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An Investigation of the Seedling Structure in the Leguminosæ.

By ROBERT HAROLD COMPTON, M.A., Frank Smart Student of Gonville and Caius College; late University Frank Smart Student; Junior Demonstrator in Botany, University of Cambridge. (Communicated by Prof. A. C SEWARD, M.A., F.R.S., F.L.S.)

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INTRODUCTION.

THE investigations of Seedling Anatomy published during the Nineteenth Century were largely descriptive; their object was the establishment of morphological criteria and definitions of such concepts as the collet, hypocotyl, &c. A variety of types, culled from widely-separated groups of plants, were usually selected for examination; with the result that a broad but vague knowledge of the anatomical tendencies of seedlings was obtained. During the past decade a new and vigorous interest has been aroused in the morphology and anatomy of juvenile forms; the stimulus being the expectation that a study of ontogeny will yield, in plants as in animals, valuable phylogenetic data. In the Pteridophyta this hope has been amply justified; but in the Phanerogams, with certain notable exceptions, the results have so far been meagre and disappointing.

It has, however, been realised that the eclectic method of investigation of the Nineteenth Century must give place to the detailed study of the phenomena within systematically restricted groups of plants. In this way a great mass of information has been acquired from several circles of affinity. Thanks to the researches of T. G. Hill and E. de Fraine (1908–1910) and others, we possess a considerable insight into the seedling structure of the Gymnosperms; but the Angiosperms present a broad field of investigation, which is quite insufficiently explored.

The comprehensive researches of Goldsmith (1876), Gérard (1881), Dangeard (1889), and Chauveaud (1911), and the more special investigations of Dodel (1872), Sterckx (1900), Sargant (1903), Wright (1904), A. W. Hill (1906), T. G. Hill (1906–1908), Brandza (1909), Smith (1909), and de Fraine (1910), among other authors, have elicited much important information on the processes which occur in the transition region of the Angiosperm seedling. The extended researches of Tansley and Thomas (1904, 1906, 1907) are not yet published in full, but promise to throw much light on the problems of seedling anatomy. Except in Miss de Fraine's work on the Cactaceæ, however, little has been done towards correlating the various types of seedling structure with other vegetative features.

From the standpoint of phylogeny, as well as from that of the better comprehension of anatomy, it is clearly important to determine, with as much precision as possible, what relations exist between the seedling structure and the size, form, habit, and general morphology of the species. It is with this object in view that the present investigation has been undertaken, at the suggestion of Mr. A. G. Tansley, to whom I owe a deep debt of gratitude for help and inspiration. The Leguminosæ were selected for study because of the great variety they display in the habit of the mature plant and in the external characters of the seedlings.

The following paper is divided into three parts:—

(A) A detailed description with figures of the anatomical features exhibited in the transition region of a number of species of Lèguminosæ; supplemented by histological and other details when occasion demands.

(B) A classified summary of the information at present available on the chief anatomical characters of the seedlings of Leguminosæ.

(C) A general discussion of the relations between seedling anatomy and other vegetative features, together with further facts bearing on the subject.

METHODS.

Most of the seedlings investigated were grown from seeds supplied by Mr. Irwin Lynch, Curator of the Botanic Garden, Cambridge, to whom I am deeply grateful for his unstinted kindness in obtaining seeds from many other sources. I am also much indebted to Mr. F. R. Parnell, of Mozafferpore, and Mr. F. W. South, of Barbados, for contributions of seeds.

The seeds were sown in soil at a suitable depth, and were for the most part germinated in a greenhouse. In the case of "hard" seeds, which are so abundant in the Leguminosæ, recourse was had to piercing the testa or treating the seeds with strong sulphuric acid before sowing.

The seedlings were uprooted when sufficiently grown; the standard age in the case of most epigeal species is the end of the first phase of growth, when the cotyledons are fully expanded and the plumule is as yet undeveloped. In many cases, however, the plumule develops so early that the first and second phases of growth overlap: and it is obvious that the criteria used for epigeal do not apply to hypogeal species. Therefore no constant standard founded on external appearance can be used throughout the Leguminosæ. Uniformity can, however, be attained anatomically by describing primary vascular structures at their full development, though it frequently happens that cambial activity begins before the primary structure is fully differentiated.

The seedlings were preserved, some in 70 per cent. alcohol and some in Carnoy's fixing fluid (transferring to spirit); but the best method for the present purpose was found to be simply immersion in methylated spirits, and this was adopted in the majority of cases.

The structure was investigated by means of transverse (and occasionally longitudinal) sections. In the case of the largest seedlings these were cut by hand, but in most cases the material was embedded in paraffin and microtome series were prepared.

The sections were double-stained: the best results with the microtome sections were obtained by the use of Methyl Violet in 50 per cent. alcohol, followed by a solution of Erythrosin in clove-oil. The sections were cleared in clove-oil and mounted permanently in Canada balsam. For the hand-sections Methyl Violet followed by Bismarck Brown was found to give highly satisfactory results. In a few cases sections were mounted in glycerine or Schultz's Solution: and for quick examination a one-solution mixture of Methyl Violet and Licht Grün was occasionally useful.

The work has been carried out at the Cambridge University Botany School, where I have enjoyed the facilities kindly placed at my disposal by Professor A. C. Seward.

The descriptions which follow were, in the majority of cases, prepared from an examination of several seedlings of each species. In a few instances a single specimen alone was examined, but where there is reason to think that this is not typical a note is inserted to that effect. It is probable that in some variable species, e. g. *Voandzeia subterranea*, *Vicia Faba*, examination of further specimens will supplement the account here given. In by far the greatest number of species, however, the mode of transition and the structure generally have proved extremely constant.

For the most part the transition is described, beginning at the primary root and ascending to the cotyledons. The reverse mode of description has, however, been taken into consideration, and is used for convenience in a few special instances.

TERMINOLOGY.

The terms *collet* and *external collet* are used for descriptive purposes in the sense in which the latter is employed by Sterckx (1900, p. 75); *i. e.* as signifying the line of junction between the piliferous layer and the epidermis proper.

The word *hypocotyl* is used to indicate that part of the axis between the cotyledonary node and the external collet. (See p. 90.)

By the term *transition*, as technically employed in this paper, is understood the changes which occur in the disposition of the vascular tissues only: the phenomena exhibited by other tissue-systems are outside the scope of the present study.

PART A.

DETAILED DESCRIPTION.

MIMOSOIDEÆ.

ACACIEÆ.

ACACIA.

Four species of this large genus have been examined, and all show close similarity in form and structure, with slight differences in detail. The germination is epigeal: the seedlings are comparatively slender, the cotyledons slightly thickened and early falling off. At the base of the hypocotyl just above the insertion of the primary root is a prominent ring or collar consisting entirely of cortical parenchyma with no special vascular system. This collar is concerned in the fixation of the seedling in the soil and in its extrication from the testa (Klebs, 1885, p. 544). It is present in many other Mimoseæ and also in certain Cæsalpinioideæ and Papilionatæ (e. g. *Mimosa pudica*, *Leucæna glauca*, *Petalostylis labicheoides*, *Sesbania aculeata*). The diameter of the hypocotyl given in the table is taken immediately above this collar.

ACACIA DORATOXYLON, *A. Cunn.* (Pl. 2. figs. 18–23.)

Tall shrub or small tree. Cotyledons oblong-ovate, slightly thickened.

The root contains a solid tetrarch xylem star, the protoxylems being equidistant (fig. 18). The phloems are characterised by the presence of a central group of clear cells with scanty contents, but not fibrous; the more densely protoplasmic tissues lying on either side of this group. Similar histological structure is exhibited by the phloem of the other *Acacia* spp. examined.

A parenchymatous pith begins to appear a few mm. below the external collet (fig. 19), and dilates rapidly, forcing the xylem into a tangential position. At the level of the collar the xylem is in the form of a closed ring 1–2 cells thick, enclosing a large pith, the protoxylem forming four projecting corners (fig. 20).

As we ascend the hypocotyl the xylem becomes reduced in bulk and breaks along the major and minor axes of the slightly elliptical stele, separating each protoxylem into halves: thus there are produced half-way up the hypocotyl four tangential bands of metaxylem with protoxylem on their eight margins (fig. 21). The phloem remains unchanged in position, so that but for the position of the protoxylems the stele would contain four typical collateral bundles. In the upper half of the hypocotyl the xylem is still further reduced in bulk and becomes more endarch, and towards the cotyledonary node a pair of ordinary collateral bundles is produced at each end of the ellipse (fig. 22). These pass out without further change to the cotyledons (fig. 23). No median protoxylem is present between the two bundles of the cotyledon trace in the mature state.

EU-MIMOSEÆ.

MIMOSA PUDICA, *Linn.*

A medium-sized shrub, with sensitive leaves *. The hypocotyl possesses at the base, just above the collet, a projecting rim or collar, which is 1·7 mm. in diameter. This is a point of agreement with the Acacieæ. The hypocotyl tapers slowly to the primary root. The cotyledons are ovate, sagittate at the base, shortly stalked. De Candolle (1825, p. 19) gives a figure of the seedling.

The root contains four narrow 1–2-seriate xylem plates, which meet in the centre of the stele. The phloem is without fibres. A pith appears below the collet, and the four xylem plates are separated from one another; they gradually broaden internally, and at the external collet they assume the V-shape. Broadening of the xylem groups continues as we ascend the hypocotyl, and half-way up they are in the tangential position: the number of xylem elements is somewhat reduced during the transition, and the reticulate vessels are replaced by spiral. Fibres appear in the phloem in the lower part of the hypocotyl, but die away higher up.

In the upper half of the hypocotyl the polar groups of xylem decrease considerably in bulk, and each splits into two halves. The lateral groups also divide in half, but maintain their original strength. As the node is approached the stele becomes elliptical and the halves of the lateral xylems separate widely, making room for the appearance of the plumular traces. 2 mm. below the node four bundles are found at each end of the ellipse: just above this they fuse in pairs, so that each cotyledon trace consists of two broad collateral bundles, which are now endarch. There is a short cotyledonary tube, and small stipules are borne on the cotyledon petioles; the cotyledons also bear the axillary buds.

A zone of small-celled collenchyma is present in the cortex, as in *Acacia* spp.

---

* The cotyledons are also sensitive, but on stimulation move upwards, whereas the ordinary foliage leaves move downwards.

SCHRANKIA UNCINATA, *Willd.*

A perennial herb with tuberous rhizome. Hypocotyl with projecting one-sided ring at the base tapering slowly to a long primary root. Cotyledons ovate.

The structure is very similar to that of *Mimosa pudica*, with the following differences:—Fibres are present in the primary phloem of the root. Owing to the shortness and greater diameter of the hypocotyl the changes are compressed as compared with *Mimosa pudica*, the condition at the cotyledonary node being very similar in the two cases.

LEUCÆNA GLAUCA, *Benth.*

A low erect tree. Hypocotyl with ring at the base, tapering slowly to a long primary root. Cotyledons ovate-oblong, cordate at base.

The root has a pith throughout, around which are present four equidistant V-shaped groups of xylem. The phloem is without fibres. At the collet ring each xylem has broken into a triad consisting of a central protoxylem and a pair of lateral metaxylems. Tannin-sacs appear here in the phloem, and a band of thick-walled fibres extends between each phloem and the endodermis. The fibres decrease and the tannin-sacs increase in number as we ascend the hypocotyl. There are two zones in the cortex separated by a layer of small crushed cells (cf. *Mimosa pudica*, *Acacia neriifolia*, &c.). The epidermal cells are often prolonged into non-septate hairs.

This condition persists for about three-quarters of the length of the hypocotyl, the xylem gradually lessening in quantity in the polar triads, but not so much so in the lateral triads. The lateral protoxylems divide and join their respective metaxylems, which become much spread out just below the node. Each cotyledon receives four xylem bands (those derived from the lateral root-poles being much stronger than those from the polar groups) and a vestige of the polar protoxylem in the median cotyledonary plane. Each xylem band has its own phloem group.

The weakening of the polar relatively to the lateral xylems in the hypocotyl is a feature in common with the other Eu-Mimoseæ studied (*Mimosa pudica*, *Schrankia uncinata*); but *Leucæna glauca* differs from these others in various anatomical and histological characters which are in part correlated with the superior size of the seedling.

INGEÆ.

ALBIZZIA MOLUCCANA, *Miq.*

The following description is based on a single specimen:—

Hypocotyl uniform, except for a prominent one-sided collar at its base. Cotyledons ovate.

The root is tetrarch, a small pith being surrounded by a continuous ring of xylem with projecting protoxylem corners. The early stages of the transition are very like those in *Acacia* spp. The ring of xylem enlarges in diameter and breaks at the collet region, at the protoxylems, so that four metaxylem bands are formed, each with protoxylem edges. A prominent phloem group lies exactly over each of these xylems, so that the structure is stem-like, except that the xylem is differentiated tangentially instead of centrifugally. This structure continues up the hypocotyl to within 3 mm. of the cotyledonary node. At this level a feature appears which recalls that found in some Eu-Mimoseæ. Each of the four xylem bands gives off a branch towards the major axis of the elliptical stele; consequently, of the four xylem bundles supplying a cotyledon, the two inner ones are smaller than the two outer. (Cf. *Mimosa pudica, Leucæna glauca,* &c.) Two phloem groups enter each cotyledon.

The transition phenomena thus appear to combine features characteristic of two tribes, the Acacieæ and the Eu-Mimoseæ. A zone of thick-walled, small-celled tissue occurs in the cortex of the hypocotyl beneath the second or third subepidermal layer (Pl. **2**. fig. 24). Fibres occur in the primary phloem of the hypocotyl.

PITHECOLOBIUM SAMAN, *Benth.* (Pl. **2**. figs. 25–28.)

A tall tree. The hypocotyl tapers gradually to a stout primary root. The cotyledons are oblong, almost sagittate at the base, erect, fleshy, caducous. The seedling is figured by De Candolle (1825, p. 19).

The root (fig. 25) contains a good-sized pith throughout. A few mm. below the external collet the root is octarch, containing eight Y-shaped primary xylems surrounding a large pith and alternating with as many phloems. No fibres are present. Just below the collet eight protoxylems are still present, but only every other one is at all well marked; the root is in process of change to a tetrarch condition (fig. 26). Tetrarchy is attained just above the collet, the four alternate xylems having completely disappeared. The xylem is now arranged in four broad tangential bands of metaxylem with median externally projecting protoxylem points. The phloem remains in eight groups, one lying dorsally to each of the metaxylem wings; there are occasional signs, however, of the phloems fusing in pairs. The pith has now dilated very considerably, and continues to do so at the expense of the cortex as we ascend the hypocotyl. Fibres appear at the base of the hypocotyl, lying just outside the phloems. The xylem is much less bulky in the hypocotyl than at the base of the root, and continues to decrease all the way up the hypocotyl. Half-way up the hypocotyl the eight phloem groups have been reduced to four by fusion of adjacent pairs between the planes of the protoxylems. The xylems now break up—each polar xylem into a median protoxylem and a pair of metaxylems; each lateral xylem into two groups of metaxylem with protoxylem on their adjacent edges (fig. 27). The stele then becomes somewhat elliptical, and the lateral groups separate further and move to join the polar groups. Immediately below the node the bundles from polar and lateral xylems respectively are almost contiguous, but they retain their individuality, and so pass out to the cotyledons; each cotyledon receives five groups of xylem, viz. a median root protoxylem (over which the phloem is interrupted), the two polar metaxylems, and the pair of bundles derived from the lateral root xylems; the phloem is in two long bands, which arch over the metaxylem groups (fig. 28).

The reduction of the octarchy of the root to tetrarchy in the hypocotyl is a rare occurrence, and though constant in this species has not been observed elsewhere in the Leguminosæ.

Pithecolobium Unguis-cati, *Benth.* (Pl. **2.** figs. 29–33.)

Erect shrub or tree. Hypocotyl narrowing slowly to a long primary root. Cotyledons enclosed in the testa, petiolate, sagittate at the base. Epicotyl with long tapering internode, bearing first one or two minute trifid scales and then alternate pinnate leaves.

The root contains a fair-sized pith and four similar equidistant wedges of xylem, with alternating groups of phloem (fig. 29). As we ascend towards the hypocotyl the section becomes elliptical and the xylems spread into the V-shape; the polar groups remain continuous for some time, while the intercotyledonary groups separate into triads (fig. 30). At the collet the polar xylems have also divided into triads, and the metaxylems of each have fused with the adjacent metaxylems from the lateral xylem triads. The four protoxylems remain in their original positions. The phloems extend in a long band over each joint metaxylem group (fig. 31). Just below the cotyledonary node the metaxylem bands divide again with the corresponding phloem; the original lateral metaxylems are left behind to pass into the epicotyl together with the lateral protoxylems, while each cotyledon receives only the polar triad (fig. 32). The first epicotyledonary internode contains six endarch collateral bundles, three passing to each of the first two leaves; these are derived from the lateral root-poles (fig. 33). Thus, two of the root xylems are cotyledonary, two plumular, this including both proto- and metaxylem.

The following histological features may be noted:—The outer cortex of the root and hypocotyl contains strong collenchyma. There is a very strongly thickened perimedullary zone of fibres embedding the primary xylems.

The anatomy shows considerable differences from that of *P. Saman*, and may be compared rather with *Cæsalpinia sepiaria*.

ADENANTHEREÆ

Adenanthera pavonina, *Linn.* (Pl. **2.** figs. 34–37.)

An erect tree. The hypocotyl narrows rather rapidly to the primary root.

The cotyledons are erect, large and fleshy, ovate with a cordate base. Lubbock figures the upper part of the seedling (1892, p. 469).

The root is tetrarch, containing four wedge-shaped groups of xylem surrounding a pith which is present throughout (fig. 34). 5 mm. below the external collet the metaxylem forms a continuous ring, 3–4 cells thick, round a fair-sized pith; the four protoxylems project outwards from this ring (fig. 35). The pith dilates as we ascend to the collet, and the ring of xylem becomes more extended. The phloem remains in four long arcs, and no fibres are developed. In the lowest 5 mm. of the hypocotyl the amount of xylem is considerably reduced, and the ring breaks up into four triads, each comprising a median protoxylem and a pair of metaxylem wings (fig. 36); the triads lateral to the now elliptical stele are somewhat longer tangentially than the terminal ones. The reduction in bulk of the xylem continues throughout the hypocotyl. The lateral protoxylems split and join their metaxylems just below the node. Each cotyledon receives five bundles of xylem, viz. a polar protoxylem, a pair of polar metaxylems, and a pair of lateral metaxylems with their protoxylems attached. The phloem, however, remains in two long tangential bands, the gap between them being over the polar protoxylem (fig. 37).

CÆSALPINIOIDEÆ.

AMHERSTIEÆ.

Tamarindus indica, *Linn.*

A large tree. The hypocotyl is uniformly thick except just below the cotyledons, where it narrows somewhat. The cotyledons are squarish-oblong, rather thick and fleshy, erect and clasping the young plumule, later caducous, stout. The axis narrows gradually below the external collet to the long and rather stout primary root. A curious feature is the early development of cork in the hypocotyl; the phellogen is situated deep in the cortex; by the time the cotyledons have fallen off the hypocotyl is brown, contrasting sharply with the green stem above the cotyledonary node. De Candolle (1825, p. 24) gives a figure of the seedling.

The root contains a large pith throughout. The xylem forms a continuous band surrounding the pith: this mainly consists of metaxylem, but secondary xylem develops very early; the protoxylems are four in number, but are rather feeble, and project slightly on the exterior of the metaxylem ring. The phloem is in four long bands alternating with the protoxylems. A phellogen commences activity very early, and the cortex is quickly thrown off.

At the external collet the pith is of great size: the primary xylem is in four triads, each being composed of a small median protoxylem and a pair of metaxylems. The four triads are all similar: they are united by a continuous band of secondary wood, but are quite easy to distinguish therefrom by their slightly different reaction to stains. Four bands of phloem are present, extending between the protoxylems. Very many large tannin-sacs are developed throughout the hypocotyl in the phloem and in the perimedullary zone, and also in the epidermis and two subepidermal layers.

Immediately above the collet the metaxylem begins to break up into smaller groups; about twenty of these are found throughout the greater part of the hypocotyl. They are scattered fairly evenly all round the stele, and but for the gaps in the bands of phloem and pericycle fibres it would be impossible to locate the original positions of the root protoxylems. Each cotyledon takes two bands of phloem and fibres, and a long strip of xylem tissue containing many scattered small endarch bundles.

The detailed behaviour of the vascular system is very difficult to work out, owing to the great division of the xylem groups, and because of the confusion caused by the tremendous development of tannin tissue. It seems fairly clear, however, that all the root xylem passes to the cotyledons, and that the plumular bundles do not contribute to the primary structure of the root.

TRACHYLOBIUM HORNEMANNIANUM, *Hayne.*

Hypocotyl swollen at the base, rapidly narrowing to root. Cotyledons fleshy, ovate, with deep dorsal median longitudinal furrows.

The features of transition agree to a large extent with those of *Tamarindus indica.* The transition is low: the tetrarch root has a large pith throughout and an almost continuous ring of xylem; triads are formed at the collet, and the hypocotyl is stem-like. It was possible here to determine definitely that the whole of the root xylem connected directly with the cotyledons.

Tannin-sacs are present in the phloem, and subepidermal secretory cavities.

SARACA CAULIFLORA, *Baker.*

Hypocotyl with one-sided collar at its base; tapering rapidly to a long tap-root. Cotyledons thick, ovate, asymmetrical.

The seedling is of unusually tough consistency, owing to enormous development of fibres in the perimedullary zone and between the phloem and endodermis. The details of the transition are extremely difficult to make out, owing partly to the fibres and partly to the deeply staining tannin-sacs. There is little doubt, however, that the transition takes place in just the same way as in *Tamarindus indica* and *Trachylobium Hornemannianum.*

The root is tetrarch and the transition markedly low. It may be noted that Van Tieghem and Douliot (1888, p. 173) record diarchy in *Saraca* (species not named).

INTSIA AFRICANA, *Thouars.*

The hypocotyl narrows rapidly to a long stout tap-root. Cotyledons fleshy.

The root is tetrarch, four Y-shaped xylems surrounding a large pith. Fibres present in phloem. Though only four protoxylems are prolonged into the root, a large quantity of metaxylem is present in the form of many stem-like bundles between the protoxylems: this being the arrangement so far as 1 cm. below the external collet. Sections at this point show a remarkable combination of root and stem characteristics. The transition is in fact effected far below the collet. The whole of the hypocotyl has a perfect stem structure: even the root protoxylems have superposed phloem groups.

The transition is pronouncedly low, no other seedling examined surpassing it in this respect: this being doubtless correlated with its massive proportions. The general structure shows affinity with other Amherstieæ.

BAUHINIEÆ.

Bauhinia variegata, *Linn.*

A middle-sized erect tree. The hypocotyl sharply narrows to a long tap-root. The cotyledons are ovate-oblong, cordate at the base, with palmate venation.

The root is tetrarch and contains a pith throughout its length. 10 mm. below the collet the xylem consists of four tangential bands with median projecting protoxylem and pairs of lateral metaxylem wings: these form a nearly continuous ring round the pith. Strong bands of fibres bound the phloem externally.

As the axis dilates below the collet the xylem ring breaks up into four isolated protoxylem groups, each with a pair of metaxylems, and usually other groups of metaxylem are left between adjacent triads. On entering the hypocotyl the lateral protoxylems also divide and join their respective metaxylem groups. All the latter acquire new internal protoxylem of their own, and so become completely endarch. Thus a stem-structure is attained at the very base of the hypocotyl and continues throughout its length.

The bulk of the xylem is reduced considerably as we ascend the hypocotyl; the pith also increases in size and the cortex narrows considerably. Just below the node the xylem tends to collect into four main groups, two supplying each cotyledon. The polar protoxylems remain between the large cotyledonary bundles in the median plane; and there are also a few small scattered bundles which pass out to the cotyledons between the two main groups. Each cotyledon also receives two long bands of phloem, separated only over the polar protoxylem.

Bauhinia Hookeri, *F. Muell.*

Cotyledons only just above ground. Hypocotyl narrowing slowly to a long primary root. Cotyledons ovate, slightly thickened.

The transition phenomena agree very closely with those observed in

B. variegata, except that, owing to the shortness of the hypocotyl, the changes are accelerated. The structure at the collet and cotyledonary node is very similar in the two species, but the intervening structures are telescoped in the hypocotyl of *B. Hookeri* as compared with *B. variegata*.

BAUHINIA ACUMINATA, *Linn.*

Erect shrub. Cotyledons unfolding just above ground.

The structure agrees so closely with that of other species of *Bauhinia*, especially *B. Hookeri*, that there is no need to describe it in detail.

BAUHINIA PURPUREA, *Linn.* (= *B. triandra*, Roxb.)

A middle-sized erect tree. This species is a close ally of *B. variegata* (p. 12), but differs markedly from that species in its mode of germination. This is half-epigeal, the cotyledons expanding somewhat beneath the ground, and turning slightly green where exposed to light. The hypocotyl is short and stout, and narrows rapidly at the external collet to a shortish primary root. The cotyledons are ovate, auricled at the base, not very thick. The epicotyl tapers upwards and the first internode is rather long *.

The structure is very similar to that of *B. variegata*, but owing to the shortness of the hypocotyl the transition phenomena are somewhat compressed.

BAUHINIA YUNNANENSIS, *Franch.*

A woody climber. The hypocotyl is of a woody consistency, narrowing rapidly to a long and little branched primary root. The cotyledons sometimes remain partially buried, sometimes spread on the surface of the ground; they are ovate in shape.

The root, a long way below the collet, is diarch, two broadly wedge-shaped groups of primary xylem being found enclosing a fair-sized pith. As we ascend to the collet the pith dilates, and the two xylems become spread out into long tangential bands arching round each end of the slightly elliptical stele. At the same time a small lateral group of xylem appears on each side of the stele: these groups at first consist wholly of metaxylem, but slightly higher up they acquire external protoxylem; so that a transition from diarchy to tetrarchy is effected.

The phloem contains, besides sieve-tubes and companion-cells, thick-walled fibres and large clear cells with dark walls. The endodermis is well marked, and many of its cells are converted into tannin-sacs.

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* The first internode in *B. purpurea* is about 30 mm. long, whereas in *B. variegata* it is only 5 mm. Thus the lengths of epicotyl and hypocotyl are in some degree complementary, and the first foliage leaves are carried high above the ground in both cases. Compare the epigeal *Cæsalpinia pulcherrima*, whose first internode is about 15 mm. long, and the hypogeal *C. Sappan*, where it is 40 mm. long. A similar relation has been observed in *Diospyros* by Wright (1904, p. 61).

As we ascend into the hypocotyl the polar bands of xylem become reduced in bulk, and each breaks up into a median protoxylem and a pair of metaxylems: the triads so formed remain in close association. Each lateral primary xylem also divides into two halves along the minor axis, and these separate tangentially and move outwards towards the metaxylem groups of the polar triads, with which they fuse in pairs. This process is only completed just below the node, but the short hypocotyl has throughout a stem-like structure save for the crushed polar protoxylems.

The passage from diarchy to tetrarchy is of interest, and may be compared with the similar phenomenon in *Liriodendron tulipifera*, also an arboreal species (Thomas, 1907, p. 81). The occurrence of diarchy in the Bauhinieæ has already been recorded by Van Tieghem and Douliot in *Cercis* (1888, p. 173).

The structure of *B. yunnanensis* agrees closely with other Bauhinieæ with short hypocotyls, when once tetrarchy has been attained.

BAUHINIA TOMENTOSA, *Linn.* (Pl. **3.** figs. 42–45.)

Hypocotyl narrowing gradually to root. Cotyledons ovate, thin. De Candolle (1825, pl. 26) and Lubbock (1892, i. p. 463) give figures of the seedling.

The slenderest species of *Bauhinia* examined. The type of transition is, however, identical with that of other species, except that the transition-changes are shifted slightly higher up the hypocotyl. The root is tetrarch, with a fair-sized pith (fig. 42). The position of fig. 43 is reached at the collet, and of fig. 44 about a quarter of the way up the hypocotyl. The diagrams are taken from this species, though they apply equally well to other *Bauhinia* spp. (p. 15).

BAUHINIA RACEMOSA, *Lam.* (Pl. **3.** figs. 38–41.)

Shrub or small tree. Cotyledons on the surface of the ground. Hypocotyl narrowing gradually to a long root. Cotyledons ovate.

The root shows variability in the number of protoxylems, but six appears to be the normal number. The processes of transition in hexarch seedlings are best understood from the diagrams. Fig. 38 shows the condition at 1·5 mm. below the collet. At the collet the xylem ring has broken into six bands arranged tangentially, each with one of the protoxylems (fig. 39). The division, however, has not occurred symmetrically, but has taken place as indicated by the dotted lines in fig. 38. The two bands in the cotyledonary plane and two others are double, with the protoxylem median: the remaining two have their protoxylems on the edge towards the intercotyledonary plane. Fig. 40, showing the condition half-way up the hypocotyl, indicates the destiny of the several bundles. All the protoxylems are cotyledonary, and so are the metaxylems with the exception of two groups, indicated by cross-hatching, which supply the first two plumular leaves. The usual pair of collateral bundles and median protoxylem are found at the cotyledonary node.

The derivation of this type of structure from the usual *Bauhinia* type is quite clear, the differences being due to the prolongation of the two main plumular traces into the root, where they contribute to the metaxylem; the result of their presence being that the two lateral protoxylems on each side, which (tracing the process downwards) usually fuse to form the intercotyledonary poles of a tetrarch root, are kept apart and become the lateral poles of a hexarch root. This interpretation is borne out by the occurrence of seedlings with a tetrarch root, whose lateral xylems separate below the collet while the polar xylems are still continuous (fig. 41).

BAUHINIA : SUMMARY.

The genus *Bauhinia*, so far as examined, exhibits certain constant features in the transition. The root is typically tetrarch (Pl. **3.** fig. 42), but through a great part of the hypocotyl six protoxylems are present with eight groups of metaxylems, this being brought about by the production of two metaxylem bundles from each root xylem and the division of the lateral protoxylems of the root to accompany their respective metaxylems (fig. 44). The hypocotyl of *B. racemosa* differs from this in the addition of the two main plumular bundles, which, being prolonged as metaxylems into the root, keep asunder the lateral pairs of protoxylems, so that a hexarch root is the result (figs. 38–40). In the upper part of the hypocotyl the stele has a quadrangular outline: the cotyledon trace consists of a pair of collateral endarch bundles with an isolated median protoxylem (fig. 45).

Diarchy occurs in the root of *B. yunnanensis*, and, according to Van Tieghem and Douliot, in *Cercis*: in the former the symmetry becomes tetrarch higher up and the transition is normal.

Phloem-pericycle fibres occur in root and hypocotyl, and also copious tannin-sacs.

The seedlings are usually of considerable diameter; several show a tendency to become hypogeal. The transition is low, even in the comparatively slender *B. tomentosa*.

CASSIEÆ.

CERATONIA SILIQUA, *Linn.*

A tree 7–10 metres high. Hypocotyl narrows rapidly into a long tap-root. Cotyledons ovate. De Candolle (1825, pl. 23) gives a figure of the seedling. Dangeard (1889, p. 86) and, later, Tansley and Thomas (1906, p. 762) have examined the anatomy of this seedling, and mention that it has a tetrarch root and exhibits a low transition, but their detailed results are not published.

The root, a long way below the collet, shows four V-shaped groups of primary xylem surrounding a pith. The pith dilates as we pass up towards the collet, and the xylem becomes more and more tangential. At the collet the xylem lies in four tangential groups, forming an almost closed ring round the pith; each group has a small median projecting protoxylem. The phloem is in four long bands extending between the protoxylems. So far there is no difference visible between polar and lateral groups of xylem, but half-way up the hypocotyl the distinction becomes clear. The four groups have all broken into pieces: each polar group consists of two metaxylem bands with an isolated protoxylem in between; whereas each lateral group consists of two xylem bands only, the protoxylem having divided with the metaxylem. Higher up the hypocotyl the xylems become more diffuse in texture, and each breaks up into a number of smaller endarch bundles. Rearrangement and fusion take place in the uppermost 5 mm. of the hypocotyl, and each cotyledon trace comprises a large median bundle, formed from the polar group by fusion in the middle line of the bundles into which it had broken, and a pair of broad loose lateral bundles, each derived from half a lateral xylem. Thus the cotyledons receive the whole of the vascular tissue that has come up the hypocotyl from the root.

Cassia.

The seedlings examined exhibit a very uniform structure, which will be described in detail in *C. lævigata*. With this species *C. floribunda* agrees closely: the other species examined have somewhat narrower diameter, and reflect this difference in the fact that the metaxylems of adjoining triads fuse laterally; so that four tangential bands are present in the hypocotyl instead of eight, in addition to the four protoxylems. The structure then approximates to the *Acacia* type.

The seedlings are epigeal, the hypocotyl being slender, hairy in its upper portion; and the cotyledons being very flat, thin, and leaf-like. A clear yellow pigment is present in the tissues, including the root; and on immersion in spirits the colour becomes purplish brown.

Except in *C. lævigata* and *C. floribunda* the cortex of the hypocotyl contains a narrow zone of small cells, with walls not specially thickened, situated one to three layers from the epidermis. These have doubtless a mechanical function in virtue of the relatively high proportion of cell-wall to lumen, and they may be compared with similar cells in several Mimosoideæ, though in the latter the walls are sometimes thickened (*Albizzia moluccana*). Tannin-sacs are absent. Stout fibres bound externally the phloem groups in the hypocotyl.

The transition in each case appears to be best described as "intermediate-low"; it begins a few millimetres below the external collet, but is completed only just below the cotyledonary node, the greater part of the hypocotyl having a very uniform structure (cf. *Acacia*).

Cassia læviGATA, *Willd.* (Pl. **2.** figs. 46–50.)

Erect shrub. Hypocotyl tapering gradually to a long tap-root. Cotyledons ovate.

The root is tetrarch; the shape of the solid xylem star is a little unusual, the arms being 3–4-seriate, and there being a deep sinus between each pair of arms in which lies the phloem (fig. 46). A pith begins to appear about 5 mm. below the collet, and at the collet the xylem is spread into a continuous tangential ring surrounding the pith, with four projecting protoxylems (fig. 47). As we ascend the hypocotyl the ring becomes broken into four triads, each composed of a median protoxylem and a pair of metaxylems (fig. 48). This condition is found through the greater part of the hypocotyl, but the quantity of xylem diminishes from below upwards. The phloem remains unchanged throughout, never undergoing division. The metaxylems fuse in pairs about 2 mm. below the cotyledonary node, and the lateral protoxylems divide immediately after, the polar protoxylems remaining *in situ* (fig. 49). The metaxylem at this level has become completely endarch. The cotyledon trace consists of a median protoxylem and a pair of broad endarch collateral bundles bounded externally by pericyle fibres (fig. 50).

Cassia floribunda, *Cav.*

Erect shrub. Cotyledons ovate. Agrees with *C. lævigata* in all essential respects.

Cassia brasiliana, *Lam.*

Tree. Hypocotyl tapering very gradually to a long primary root. Cotyledons ovate, prominently palmately veined.

The hypocotyl is of rather hard consistency, owing to the cortical mechanical zone, the pericycle fibres, and the fibrous development of the perimedullary zone.

Cassia siamea, *Lam.*

Low tree. Cotyledons ovate.

Cassia sumatrana, *Roxb.*

Low tree. Cotyledons ovate, midrib dichotomising half-way along.

These two species, said by the Kew Index to be identical, show no novel points of structure beyond those already mentioned.

Labichea lanceolata, *Benth.*

Shrub or sub-shrub. The hypocotyl contracts remarkably from a diameter of

2·5 mm. at the collet to 1·0 mm. at the cotyledonary node; narrows rapidly to a slender root. Cotyledons ovate.

Only one seedling was obtained, and this was probably somewhat smaller than normal. The transition was of the intermediate-low type found in *Cassia* spp., the details of structure closely resembling those described for *C. lævigata.* The distension of the base of the hypocotyl involves the cortex only, the stele not being proportionately enlarged.

Pith appears about 3 mm. below the collet; triad-formation is achieved at about a quarter of the way up the hypocotyl; fusion of metaxylems, division of lateral protoxylems, and the organisation of the cotyledon traces occur in the upper quarter of the hypocotyl.

PETALOSTYLIS LABICHEOIDES, *R. Br.*

Hypocotyl tapering upwards in a remarkable manner (cf. *Labichea lanceolata*), and contracting sharply to the root; a prominent serrate collar is developed at the collet. Cotyledons ovate.

The transition is exceptional among the Cæsalpinioideæ, in that it is high. The root contains a small tetrarch stele with four equal 2-seriate xylem plates meeting at the centre. These separate slightly from one another just above the collet, but throughout the lower three-quarters of the hypocotyl four exarch xylem-wedges are found, the whole aspect of a section being root-like. The contrast at the collet between the broad cortex and the narrow stele is striking.

About 3 mm. below the cotyledons the xylems become distinctly double, consisting of paired irregular groups of metaxylem with mesarch protoxylems. The lateral xylems divide about this level and join the polar groups, so that each cotyledon receives a pair of xylem bands with a median polar protoxylem and two groups of phloem. The transition is incomplete at the node.

Clearly the distension at the base of the hypocotyl does not affect the transition phenomena of this essentially slender seedling. (Cf. *Labichea lanceolata*, *Kennedya retusa*, &c.)

EU-CÆSALPINIEÆ.

PARKINSONIA ACULEATA, *Linn.*

Shrub or small tree. Hypocotyl with prominent collar at base, below which it tapers rapidly to a long root. Cotyledons ovate, thin. Figured by De Candolle (1825, pl. 22).

The root has a pith throughout: it contains a continuous ring of primary xylem with four projecting protoxylems. This ring breaks into four tangential bands, each with a median protoxylem just below the collet; the amount of xylem is reduced gradually as we ascend, and triads are produced about half-way up the hypocotyl. The phloem remains in four prominent rounded groups throughout, fibres being present in its tissues in the lower part of the hypocotyl. About 5 mm. below the cotyledons each polar triad is in the form of a small median protoxylem and a pair of collateral bundles : the lateral xylems being much spread out tangentially, and dividing to join the polar groups. Just below the cotyledons the lateral half-xylems join the polar collateral bundles : so that each cotyledon receives a pair of collateral, more or less endarch, bundles and a tiny median protoxylem.

The structure agrees in the main with that described in *Bauhinia tomentosa.*

ACROCARPUS FRAXINIFOLIUS, *Wight & Arn.*

Hypocotyl narrowing gradually to the root. Cotyledons ovate.

The single seedling examined differed chiefly from *Parkinsonia aculeata* in the fact that the phloem begins to divide at the collet, with the production of eight strands, which continue up the hypocotyl to just below the cotyledons, where they again fuse in pairs. Each cotyledon receives a minute polar protoxylem and four bundles of xylem derived from the polar metaxylems and the lateral root xylems in the usual way. Thus the diameter, superior to that in *P. aculeata*, allows of a greater spreading-out of the vascular system than in that species.

CÆSALPINIA CORIARIA, *Willd.*

A small shrub. Hypocotyl uniform, save for a slight swelling just above the collet. Cotyledons ovate, stalked, almost sagittate at the base.

Similar on the whole to *Parkinsonia aculeata*, but the polar xylems never spread out sufficiently to become triads ; they divide, with their protoxylems, just below the cotyledonary node, and join the lateral half-xylems. The phloem remains throughout in four groups. Thus the cotyledon trace consists of a pair of collateral bundles ; no polar protoxylem was observed.

CÆSALPINIA PULCHERRIMA, *Sw.*

A shrub or small tree. The hypocotyl tapers gradually to a long primary root. Just above the external collet is a slightly protruding ring of cortical tissue only. The cotyledons are oblong, rather broader distally, shortly stalked, and auricled at the base, caducous. De Candolle (1825, pl. 23) gives a figure of the seedling under the name *Poinciana pulcherrima.*

The root is tetrarch. Pith is present throughout. 2 mm. below the collet we find four broad exarch wedge-shaped masses of primary xylem situated around a large pith and alternating with four scarcely fibrous arcs of phloem. Just above the collet the structure is the same except that bands of fibres lie outside the phloem arcs, and appear to be pericyclic in nature, though this is difficult to determine. The cortex and pith in the hypocotyl, and to a greater extent in the cotyledons, contain many tannin-sacs.

Half-way up the hypocotyl the pith has further increased in diameter at the expense of the cortex. The bands of fibres now extend in a continuous ring all round the stele, even over the position of the root protoxylems. The xylem is now in the usual four triads, but the total bulk is diminished. The lateral triads are somewhat more spread out tangentially than are the polar. This structure is maintained to within 3 mm. of the cotyledonary node. Each of the root protoxylems then divides, and the halves join their respective metaxylems. The polar metaxylems give off external branches, the internal parts then fusing in the median plane, so that three bundles are found at each end of the stele, 1 mm. below the cotyledons. Meanwhile the phloem has united over the ends of the ellipse, so that instead of four arcs there are now only two long bands. The lateral groups of metaxylem and protoxylem separate somewhat from one another, but do not fuse with the polar groups before entering the cotyledons. Thus each cotyledon receives five endarch groups of xylem, three of which are derived from the polar, and two from the lateral root xylems; over all extends the continuous band of phloem and fibres.

The absence of fusion between lateral and polar xylems is no doubt connected with the large size of the cotyledons and their broad insertion on the hypocotyl.

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So far as could be judged from imperfect material, *Poinciana regia*, Boj., agrees fairly closely with *C. pulcherrima*.

Cæsalpinia Sappan, *Linn.*

A small tree. The hypocotyl is almost absent, there being only about 1 mm. of epidermis below the cotyledons. There is a long primary root. The cotyledons are borne on stalks a few mm. in length; the laminas are thick and are fused together by their ventral faces. The plumule develops immediately upon germination and produces a long tapering internode.

The root is tetrarch, and contains four large solid xylem wedges surrounding a fair-sized pith. A zone of fibres bounds each of the four phloem groups externally.

The mode of transition is almost identical with that found in the epigeal *Cæsalpinia pulcherrima*, with the difference that since the hypocotyl is here extremely short the transition phenomena are compressed into a very short distance. The tangential position of the xylem is attained 1 mm. below the cotyledons. 0·5 mm. below the cotyledons we find the lateral metaxylems and protoxylems separating towards the poles, the terminal groups remaining continuous. Immediately below the node each polar xylem divides into two groups, and the lateral xylems tend to break up into a number of smaller bundles ; the fibres now form a continuous ring round the vascular tissue. Each cotyledon receives four main groups of xylem, which, however, are somewhat broken in pieces.

Throughout the hypocotyl the phloem remains in four continuous bands, alternating with the planes of the root protoxylems : each cotyledon receives two such bands.

The plumular bundles, six in number, appear at the cotyledonary node : the first two leaves are opposite in the intercotyledonary plane, and each takes three of these bundles. The plumular protoxylems do not contribute to the root protoxylems, these latter being entirely cotyledonary in origin, just as in the epigeal species.

CÆSALPINIA SEPIARIA, *Roxb.* (Pl. **3**. figs. 53, 54.)

A woody climber. Hypocotyl very short, tapering to a long thick primary root. First epicotyledonary internode long, narrowing upwards : first two leaves opposite.

A species closely allied to *C. Sappan,* and showing great resemblances in its seedling morphology, but of quite distinct anatomical structure, which rather approximates to that of *Pithecolobium Unguis-cati.*

The root contains four equal stout plates of xylem surrounding a pith. As we ascend towards the cotyledons they all broaden out internally and assume a tangential position. Two of them enter the cotyledons ; the other two pass up into the epicotyl and enter the first two leaves ; the two systems of bundles being distinct both in proto- and metaxylems.

A noteworthy feature is exhibited by the plumular bundles. At the cotyledonary node these have not yet assumed the normal "stem-like" appearance with endarch xylem, but each consists of a double band of vessels developed tangentially on either side of a mesarch protoxylem fig. 53). This condition slowly changes as we ascend the epicotyl, and 10 mm. above the cotyledons the transition to the stem-structure is complete. The other epicotyl bundles are endarch from their insertion on the cotyledon traces. This occurrence of a hypocotyl-like structure in an epicotyl can hardly be regarded as other than a result of the direct connection with the root xylems. The transition from root- to stem-structure is here incomplete below the cotyledonary node. Similar though less well-marked phenomena occur in other cases where the plumular xylem is in direct continuity with the root protoxylems. (See, *e. g.*, certain Vicieæ.)

One seedling showed the peculiarity that one of its cotyledonary root-poles divided into a triad very much below the others (fig. 54). This, however, was without any great effect on the transition.

GUILANDINA BONDUCELLA, *Linn.* (Pl. **3.** figs. 51, 52.)

Climbing shrub. Very large seedling. Collet at the base of the cotyledon stalks. First epicotyledonary internode elongated.

The structure is of the same general type as that of *Cæsalpinia Sappan*, with the exception that the changes begin at a lower level (about 10 mm. below the node), this being doubtless correlated with the greater size. The protoxylems become separated from the metaxylems, and lie in groups external to them; they undergo divisions independently of one another (fig. 51, 5 mm. below the node; fig. 52, 2 mm. below the node). All the root proto- and metaxylems are cotyledonary, each trace being composed of four bundles. Stout lignified fibres bound the phloem in the upper part of the hypocotyledonary axis; and the epicotyl has a continuous ring of them within the endodermis.

PAPILIONATÆ.

SOPHOREÆ.

SOPHORA TETRAPTERA, *J. Mill.* (Pl. **3.** figs. 55–60.)

A small or middle-sized tree. Cotyledons hemispherical, opposite; plumule arising sometimes immediately between them, sometimes laterally, and developing early. First two leaves often nearly opposite.

The root contains a curious-looking diarch strand of xylem, oval in transverse section and consisting of a mixture of vessels and thick-walled elongated storage parenchyma. About 12 mm. below the cotyledons this strand breaks transversely into two similar wedge-shaped masses (fig. 55); these rapidly broaden, and each becomes converted into a continuous stout V-shaped band (fig. 56) 8 mm. below the node. These bands then break into triads, each consisting of a median crushed protoxylem and two lateral bands of metaxylem; the phloem also dividing as the stele elongates in the cotyledonary plane (fig. 57, at 4 mm. below the node). Fig. 58, at 2 mm. below the cotyledons, shows each metaxylem dividing into two groups (the section from which the figure was taken being oblique, the upper group of bundles belongs to a higher level than the lower): of these two halves of each metaxylem, one enters a cotyledon; the other remains in the axis and becomes a plumular bundle, as indicated by the dotted lines. The phloems divide in a corresponding manner. Fig. 59 shows the structure just above the node. Each cotyledon trace consists of a pair of collateral bundles with endarch xylem and a small median protoxylem. The four plumular bundles are shown branching; the four branches towards the intercotyledonary plane fuse in pairs, and six bundles are produced in the main part of the internode (fig. 60). The structure of the epicotyl is, however, subject to some variation.

SOPHORA CHRYSOPHYLLA, *Seem.*

Habit not known to the author. Cotyledons ovate, thick, opposite. First two leaves opposite.

The structure agrees so closely with that of *S. tetraptera* that further description is unnecessary.

CASTANOSPERMUM AUSTRALE, *A. Cunn.*

Tall tree. Hypocotyl practically absent; axis tapering slowly to a long stout root. Cotyledons very massive. The largest seedling studied. Lubbock (1892, p. 454) gives a figure.

There is some variety in the structure of the seedlings, which cannot be said to be fully investigated. Three seedlings showed a hexarch root, the xylem being in six roughly T-shaped groups surrounding a large pith. These gradually broaden as we ascend the axis, the metaxylem becoming tangential and the protoxylem dwindling. Each cotyledon receives three double bundles, the plumule being supplied by metaxylem and secondary xylem developed in the upper part of the hypocotyledonary axis. The whole structure recalls that described in *Æsculus Hippocastanum* by Mlle. Sophie Goldsmith (1876, p. 35).

In another seedling the root, 4 cm. below the node, showed eight equal primary xylem strands, each consisting of proto- and metaxylem. Above this one of the protoxylems disappears, and at 2 cm. below the node there are present seven metaxylem groups with protoxylem and one without. The seven complete bundles are cotyledonary, four supplying one cotyledon and three the other; the eighth metaxylem passing directly into the epicotyl.

The whole aspect of the structure is similar to that seen in certain other large seedlings, such as *Æsculus Hippocastanum*, *Fagus sylvatica* (Goldsmith, 1876), *Vicia Faba*, and *Voandzeia subterranea* (see below, pp. 55, 63).

PODALYRIEÆ.

VIMINARIA DENUDATA, *Sm.* (Pl. **4.** figs. 62–65, 67.)

Hypocotyl narrowing gradually to root. Cotyledons oblong, jointed at the base. Lubbock (1892, p. 401) gives a figure.

The root (fig. 62) is tetrarch, containing a solid xylem star with four projecting 1–2-seriate protoxylems separated by rather deep sinuses (intermediate between the condition in the tetrarch Phaseoleæ and the tetrarch Trifolieæ, for instance). The four phloems are bounded externally by fibres. A few pith-cells appear in the centre of the xylem just above the collet; these increase in number (fig. 63) and separate the xylems into four equilateral triangular groups, as seen a quarter of the way up the hypocotyl (fig. 64). This arrangement continues through most of the hypocotyl, the xylems gradually broadening internally while retaining their individual continuity. Seven-eighths up the hypocotyl the polar xylems are broadly T-shaped in section, and each lateral group is on the point of dividing into two tangential bands (fig. 65). At the node these half-laterals attach themselves lightly to either side of each polar xylem, but do not fuse completely (fig. 67). Thus the base of the cotyledon appears to have only a double bundle, which, however, quickly resolves itself into its components higher up.

PULTENÆA DAPHNOIDES *Wendl.* (Pl. **4.** figs. 62, 63, 66, 68.)

Hypocotyl tapering slowly to the root. Cotyledons oblong-ovate. Early leaves in opposite pairs.

The root is tetrarch, as in *Viminaria denudata* (fig 62) ; a pith begins to appear about a quarter of the way up the hypocotyl, dilating the xylem, the condition of fig. 63 being reached about half-way up the hypocotyl. The ring of xylem then breaks into four groups : the two polar ones being broad and tangential but still exarch, consisting of proto- and metaxylem ; the lateral ones dwindling and consisting of exarch protoxylem only (fig. 66, at three-fourths up the hypocotyl). The polar xylems break into tangential triads ; the laterals disappear completely at seven-eighths up the hypocotyl, and do not contribute to the cotyledons. Each cotyledon receives a pair of collateral bundles and a small median protoxylem all close together (fig. 68).

Plumular traces consisting of secondary xylems appear in the upper part of the hypocotyl immediately outside the dwindling lateral root protoxylems, but having no direct continuity with them : at certain levels, in sufficiently young seedlings, sections show neither root-pole nor epicotyledonary bundle ; they come into contact with one another, however, when the plumule begins to develop.

CHORIZEMA CORDATUM, *Lindl.*

Hypocotyl tapering gradually to the root. Cotyledons linear-oblong.

The account given for *Pultenæa daphnoides* applies to this seedling also, with slight differences in detail. Pith does not begin to appear till about 5 mm. below the cotyledons, so that the changes are relatively compressed.

BAPTISIA LEUCANTHA, *Torr. & Gray.* (Pl. **4.** figs. 61, 68.)

Hypocotyl tapers slowly to the root. Cotyledons rather fleshy, ovate, somewhat asymmetrical (owing to accumbency of radicle in seed).

The root contains a diarch biseriate plate of vessels, and two lateral bands of phloem without fibres (fig. 61). At the external collet the xylem plate broadens internally, and just above this level a pith appears and the xylem plate separates into two halves. Half-way up the hypocotyl each xylem has a V-shape, but the apical protoxylem is slightly separated from the lateral metaxylem arms of the V. The phloems have also divided, and lie outside the xylem arms (fig. 68). The V-shape of the xylem persists into the base of the short cotyledon-tube, with but little modification. In the base of the cotyledons the protoxylem changes its position somewhat, and the xylem double bundle becomes mesarch. Finally, just before the branching of the cotyledon midrib, the xylem becomes completely endarch and the phloems fuse dorsally over a single median metaxylem bundle; thus the transition is completed.

THERMOPSIS MONTANA, *Nutt.* (Pl. **4.** figs. 61, 68.)

Hypocotyl tapering gradually to a long primary root. Cotyledons ovate, asymmetrical, one edge being almost straight, rather fleshy.

The features of the transition are almost identical with those described for *Baptisia leucantha*, but the changes take place at lower levels; the transition being best designated "intermediate." Broadening of the diarch 1–2-seriate xylem plate occurs below the collet; and at the collet a pith is present, the xylems being Y-shaped. Half-way up the hypocotyl the metaxylems are practically tangential, with half-phloems almost superposed (fig. 68).

GENISTEÆ.

SPARTIUM JUNCEUM, *Linn.* (Pl. **4.** figs. 69–71.)

A switch plant with long narrow green woody stems, which are leafless except in moist conditions of life. Cotyledons ovate, with scarcely any tube. The whole seedling is rather firm in consistency.

The root (fig. 69) is diarch, containing massive primary xylems, not meeting at the centre, consisting of 2–3 rows of reticulate vessels and fibres with thick and strongly-staining walls. Each phloem contains a band of strong fibres. The endodermis is strongly dotted, the lignifications persisting three-quarters of the way up the hypocotyl.

Practically no change occurs below the collet. Just above, however, the xylems separate somewhat, and broadening internally become wedge-shaped, this gradually changing into a characteristic T-shape, the protoxylem lying externally to the metaxylem arms of the T (fig. 70). The phloem fibres die out in the hypocotyl; the phloem divides concurrently with changes in the xylem, so that each T-shaped xylem has a pair of phloems extending from the angles between protoxylem and metaxylem towards the intercotyledonary plane. This condition persists through the greater part of the hypocotyl.

About 5 mm. below the cotyledons each xylem splits into three groups—an effete median protoxylem and two strong lateral metaxylems, whose vessels are now chiefly spiral instead of pitted. These metaxylems move outwards slightly, through the dilation of the pith at the expense of the cortex; so that the root protoxylem comes to lie between but somewhat exterior to the members of each pair. The changes which occur in the uppermost 4 mm. of the hypocotyl consist in the admixture of the main cotyledon bundles with parenchyma, and the gradual passage of the corresponding phloems to a more dorsal position (fig. 71).

Each cotyledon takes a pair of almost collateral bundles derived from the metaxylem, and an intervening root protoxylem. Anastomoses soon take place, and this arrangement is quickly lost, a median collateral bundle being formed, which forks higher up in the cotyledon.

GENISTA ÆTHNENSIS, *DC.*

Moderate-sized shrub. Hypocotyl narrows gradually to a long primary root. Cotyledons oblong.

The two diarch plates persist to 10 mm. above the collet, gradually broadening to a wedge-shape. The characteristic T-shape is assumed about 2 mm. above this, the phloems dividing concurrently; but this lasts a very short distance compared with *Spartium junceum*, the usual triple cotyledon traces being organised almost immediately. Thus the transition is much higher than in *Spartium junceum*, and the changes are telescoped. The root and hypocotyl appear to be without fibres in the phloem.

GENISTA HISPANICA, *Linn.*

A small shrub. The hypocotyl narrows rather abruptly into the root and bears a tuft of rootlets at the collet region. Cotyledons oblong.

The early stages of the transition occur in the first few millimetres above the collet, and the T-shape is early reached by the xylem. This persists through the greater part of the hypocotyl, the later stages only taking place in the upper few millimetres. The xylem trace consists, as usual, of a pair of collateral bundles with endarch spiral xylem and with fibres outside the phloem ; between these bundles lie scattered and disorganised root-protoxylem elements.

A good deal of secondary vascular tissue develops early at the collet region, this being apparently connected with the tuft of lateral roots.

CROTALARIA RETUSA, *Linn.* (Pl. **4**. fig. 72.)

Erect undershrub, reaching 150 cm. Hypocotyl somewhat downy. Cotyledons oblong, slightly twisted to one side. Primary root very short, a tuft of lateral rootlets arising at the collet region. De Candolle (1825, pl. 6) gives a figure.

The transition begins 3 mm. below the collet, the two biseriate xylem plates broadening to equilateral wedges and then to a V-shape by the intrusion of pith (fig. 72), this occurring at the collet ; a short distance above each breaks into a triad (*cf.* Pl. **5**. fig. 73, for *C. incana*). 1 cm. below the cotyledons the metaxylems combine with the half-phloems to form four collateral stem-like bundles ; disorganised protoxylems remain at the poles ; and in this condition the cotyledons are entered.

CROTALARIA STRIATA, *DC.*

Erect undershrub, reaching 120 cm. Hypocotyl downy. Cotyledons oblong, with prominent midrib. Primary root replaced by a tuft of lateral rootlets arising from a slight swelling at the collet.

The transition is, on the whole, like that in *C. retusa* with certain differences. Broadening of the xylems begins at the collet, and a transitory Y-shape is produced, followed by a T-shape, this almost immediately giving rise to a triad, whose median protoxylem lies well outside the line of the metaxylems. Half-way up the hypocotyl the bundles have become collateral, and so persist to the cotyledons, forming, together with the median polar protoxylem, the cotyledon trace.

It may be remarked that cambial activity begins very early at the collet region, both here and in *C. retusa*: this no doubt being related with the early development of rootlets, as in many Phaseoleæ, &c. Another curious feature noted was the presence of a tannin-like substance in the vessels, a phenomenon also observed in *Phaseolus radiatus*.

CROTALARIA INCANA, *Linn.* (Pl. **5**. figs. 73, 74.)

Undershrub of 2–4 feet (Hooker, 'Flora of British India') ; erect herb, usually annual, attaining 2–3 feet (Bentham, 'Flora of Australia'). Hypocotyl narrowing gradually to the root. Cotyledons oblong, twisted to one side, and with a conspicuous lateral sinus such as is caused by the hilum of the seed (Lubbock, 1892, p. 384), making them almost falcate.

The transition closely resembles that of *C. retusa*, the early stages taking place in the collet region. Comparatively few xylem and phloem elements are developed, however (fig. 73, in lower half of hypocotyl). The cotyledon trace consists of a pair of collateral bundles with a prominent median protoxylem (fig. 74, at base of cotyledon), this structure being lost by anastomoses above the first pinnations of the veins.

LABURNUM VULGARE, *Presl.*

Fair-sized tree. The hypocotyl passes very gradually into the long taproot. Cotyledons broadly ovate, strongly veined. Lubbock (1892, p. 407) and De Candolle (1825, pl. 5) give figures, the latter under the name *Cytisus Laburnum.*

The root contains a pair of rather massive wedge-shaped xylems. The transition closely resembles that in *Crotalaria striata*, the initial Y and T stages being passed through rapidly at the base of the hypocotyl. Fibres appear to be absent from phloem and pericycle.

CYTISUS PURPUREUS, *Scop.*

Fair-sized shrub. Cotyledons ovate.

In this and the other Cytisinæ examined the root contains a continuous biseriate diarch plate of xylem lignified throughout at the end of the first phase of growth (*cf.* Pl. **5.** fig. 75 of *C. canariensis*). The phloems contain fibres. Broadening of the xylem begins just above the collet, and a Y-shape is attained about a quarter of the way up the hypocotyl, changing to a T-shape half-way up. The T-shape persists to within 5 mm. of the cotyledons, then breaking up into a triad; the lateral metaxylems quickly combine with the half-phloems to form collateral bundles. In the cotyledons these bundles fuse in the median plane when the pinnation of the midrib begins.

CYTISUS HIRSUTUS, *Linn.*

Moderate-sized shrub. Cotyledons ovate.

The transition phenomena are very closely similar to those in *C. purpureus*, but take place rather more slowly, with the results that the T-shape of xylem does not extend over so great a distance, and that the collateral position of the lateral metaxylem of the cotyledon trace is only attained about 1 mm. below the node.

CYTISUS CANARIENSIS, *Steud.* (Pl. **5.** fig. 75.)

Cotyledons ovate.

The transition phenomena so closely resemble those in *C. hirsutus* that there is no need to describe them in detail. It may be noted that the cotyledon trace retains signs of doubleness long after its pinnation, not as in *C. hirsutus*, &c., where it becomes a single median collateral bundle at the region of branching. The changes are hardly complete at the node, stem-like collateral bundles not being fully organised, so that the transition is best described as intermediate-high.

ULEX EUROPÆUS, *Linn.* (Pl. **1.** fig. 16.)

Thorny bush, with leaves and branches reduced to spines except in early life. Hypocotyl tapering gradually to the long primary root. Cotyledons only just above ground, oblong-ovate.

Though starting in the same way as in other Cytisinæ, &c., the transition phenomena differ in being incomplete within the hypocotyl; the bundles are in the "*position sécantielle*" at the node, the xylems being differentiated tangentially. The transition must be considered intermediate-high, agreeing most closely with that in *Cytisus canariensis.*

LUPINUS MUTABILIS, *Sweet.*

A low shrub. The stout hypocotyl narrows rather suddenly to a strong primary root. Cotyledons large and fleshy, rather lop-sided owing to the accumbent folding of the embryo in the seed.

Two centimetres below the collet the root is of the usual diarch type; there are two large wedges of primary xylem, the protoxylem being 2-seriate and the metaxylem broadening inwards to 6–7-seriate; a narrow pith separates the two masses of xylem. There are two long lateral bands of phloem, with one or two layers of fibres separating them from the single parenchymatous pericycle layer.

The transition takes place entirely below the external collet. The usual stages are passed through rapidly while the root is dilating to the diameter of the hypocotyl. A Y-shaped configuration is at first assumed; then the protoxylem becomes detached from the pair of massive metaxylems, which are gradually opening out into the tangential position and soon afterwards themselves separate. Meanwhile the phloems with the fibres have divided, and each of the four groups thus formed has come to lie radially outside one of the metaxylems. A redistribution of the four collateral bundles then takes place, and in the hypocotyl they are equidistant from one another; so that the cotyledonary plane can only be found by looking for the small half-obliterated root protoxylems which still lie in it.

This structure, with the addition of a few plumular bundles, continues throughout the hypocotyl. The cotyledon trace consists of the two large collateral bundles and the minute intervening protoxylem, which are all in direct connection with a single root-pole. The median protoxylem is exceptional in sometimes having a small group of phloem radially outside it, thus composing a small collateral bundle. This feature has also been found elsewhere (e. g., *Helianthus annuus*), but appears to be of very rare occurrence.

LUPINUS HIRSUTUS, *Linn.*

Stout annual herb with stems 30–40 cm. high. Hypocotyl 2·0 mm. in diameter at the base, where it is circular in section, 5·0 × 3·0 just below the cotyledons, where it is elliptical; narrows rather abruptly to a long stout primary root. Cotyledons broadly oblong, bent to one side, owing to accumbency of embryo, remaining fleshy and not becoming very leaf-like, though turning green in light.

The phenomena of transition closely resemble those in *L. mutabilis*. As in that species, the root is diarch, the transition is completed below the collet, and the whole of the hypocotyl is stem-like. Phloem, however, was not observed accompanying the median polar protoxylem in the cotyledon trace.

LUPINUS LUTEUS has been examined by Kattein (1897, p. 94), who states that cotyledons lie transversely to the plane of the root protoxylems; that the adjoining lateral pairs of collateral bundles enter the cotyledons; and that the polar protoxylems pass up into the epicotyl. These statements require confirmation, and must be considered highly improbable in the light of the phenomena shown by *L. mutabilis* and *L. hirsutus*; especially as Kattein's figures of transverse sections show a structure very similar to that in these latter species, and as a figure by Naegeli (1858, pl. 5) shows the median polar protoxylem in the base of the cotyledon of *L. luteus*. Naegeli also describes the course of the bundles in *L. Lehmanni*; but his figures and description do not indicate the structure of the root, though the hypocotyl and cotyledons seem to have the same structure as that described for *L. mutabilis*.

TRIFOLIEÆ.

ONONIS BIFLORA, *Desf.*

Hypocotyl tapering slowly to the root. Cotyledons ovate, covered with hairs. (Cf. *Lespedeza*; according to Lubbock, the only other instance of this outside the genus *Ononis* observed within the Leguminosæ.) Short one-sided cotyledon tube.

The structure in many respects recalls that observed in the Genisteæ. The root is diarch, the xylem plates consisting of 1–2 rows of stout-walled and deeply-staining vessels; the phloem contains fibres. The xylem groups begin to broaden internally at the collet, and assume at first a Y-shape, and then at 10 mm. above the collet a T-shape. They break into triads about half-way up the hypocotyl; and the protoxylems, hitherto exterior in position, come to lie immediately between the collateral bundles formed from the metaxylems and the halves of the phloems. This arrangement of bundles constitutes the cotyledon trace; the bundles, shortly after branching in the lamina, fuse in the median plane and produce a definite midrib.

The phloems are of a type not observed in the Genisteæ, but of general occurrence in the Trifolieæ. Half-way up the hypocotyl each consists of a central group of clear cells flanked on either side by a group of densely protoplasmic companion-cells and sieve-tubes.

Thus *Ononis biflora* exhibits certain characters of common occurrence in the Genisteæ, together with others found in the Trifolieæ.

ONONIS ROTUNDIFOLIA, *Linn.* (Pl. 5. figs. 76, 77.)

Cotyledons ovate, leaf-like.

The root may be triarch or tetrarch, the xylems consisting of 2–3-seriate plates of stout vessels and the phloem containing fibres (fig. 76).

In a tetrarch seedling it was found that the root-like structure continued to about half-way up the hypocotyl without change. The intercotyledonary xylem then began to diminish in bulk, and three-quarters up the hypocotyl they had disappeared completely; the four phloems, however, remained *in situ*. Thus the structure became indistinguishable from that produced in many diarch seedlings (fig. 77, at 4 mm. below the cotyledonary node, where the xylem vessels have lost the stoutness and coherence they possessed below). At 1 mm. below the node the xylems are Y-shaped, and become T-shaped on entering the cotyledons. The transition is therefore high ; and the structure exhibits some relationship to that of both Trifolieæ and Genisteæ, with the additional feature of the reduction from tetrarchy to diarchy (*cf.* certain Podalyrieæ). Two other seedlings exhibited an essentially similar structure.

In a seedling with three root xylems it was found that at the collet region two of the xylems increased their angular distance and the intervening phloem divided ; simultaneously, a fourth group of xylem appeared in the gap thus produced, and increased in size until the structure became symmetrically tetrarch. The new group of xylem was completely detached from the others. Higher up the hypocotyl the two intercotyledonary xylems disappeared as in the first instance, leaving the xylem system diarch. The new xylem is one of those to disappear, so that it has a relatively short and completely independent course in the hypocotyl.

Two other seedlings also showed triarch roots. In one case the passage to tetrarchy was effected 5 mm. below the collet. In the other a vestige of a fourth xylem appeared half-way up the hypocotyl, when the other intercotyledonary xylem was already dwindling ; the change to diarchy was made as usual, so that in this case the fourth xylem was a mere vestige only about 3 mm. in length. Such a bundle, confined to the region between half and three-quarters of the way up the hypocotyl, could hardly have much functional significance.

MEDICAGO TRIBULOIDES, *Desr.*

A sprawling annual herb. Cotyledons green and leaf-like, slightly turned to one side, the edges on one side being straight, on the other curved.

The root is tetrarch, the xylem consisting of four 1–2-seriate plates of spiral and pitted vessels, which meet in the centre of the stele. Each of the four phloems contains a group of strong fibres, which is bounded externally by the 2–3-layered pericycle, internally and laterally by an arc of thin-walled phloem. The endodermis is sharply marked with dots on the radial walls.

This configuration of the xylem persists for about two-thirds of the way up the hypocotyl without undergoing any change except the disorganisation of the spiral protoxylems. Each phloem, however, suffers a change, and comes to consist of a group of large clear cells with hardened but scarcely thickened walls flanked by a group of sieve-tubes and companion-cells on either side. The impression is given that the phloem has divided into two groups separated by conjunctive parenchyma ; but this is illusory : a little typical phloem-tissue occurs in a narrow band inside this clear-celled group, which should be regarded as the representative in the hypocotyl of the fibres in the root. The endodermal dots disappear also in the lower part of the hypocotyl.

The transitional changes of configuration begin about two-thirds of the way up the hypocotyl. The stele becomes elliptical, a small pith appears, and the xylems on the major axis move apart somewhat; the xylems on the minor axis become somewhat crushed towards the centre, while spreading internally into a broad V-shape. 5 mm. below the cotyledons the polar xylems are divided in half and the metaxylem parts are rounding up into loose groups of spiral vessels mixed with parenchyma, which pass outwards on either side of the polar root protoxylems ; the lateral xylems lie in a tangential position and soon divide into halves, each half consisting of a metaxylem group and half the lateral root protoxylem. In this condition the half-lateral xylems move tangentially and fuse with the polar metaxylem bundles.

The hypocotyl at this stage (2 mm. below the cotyledons) shows four main xylem bundles, each of which is derived from half of a polar metaxylem fused with the adjoining half of a lateral metaxylem to which the half of a lateral protoxylem is attached, the polar protoxylems retaining their position between the members of each pair of bundles.

The phloems meanwhile remain in their original positions, so that on the fusion of the half-polar and half-lateral bundles they are almost radially outside the compound xylem. The arrangement of the phloem-tissues, however, changes somewhat—the large clear cells becoming external to a continuous band of sieve-tubes, companion-cells, and phloem parenchyma.

When the cotyledonary tube becomes detached from the plumule, the vascular tissue is in the form of two pairs of almost collateral, but slightly oblique, bundles ; one pair supplying each cotyledon. The polar protoxylem lies between the pair, and the half-lateral protoxylems can be observed as small disorganised appendages to the outer edge of each xylem mass.

The cotyledonary tube is very short, and is open on the side towards the flat edge of the cotyledon laminas at a lower point than on the other ; on this side the first leaf appears.

TRIGONELLA FŒNUM-GRÆCUM, *Linn.*

Hypocotyl tapers slowly to root. Cotyledons oblong-ovate, jointed to a petiole 2 mm. long, penninerved. De Candolle (1825, pl. 6) gives a figure.

The root is tetrarch, and the whole structure agrees so closely with that of *Medicago tribuloides* that there is no need for further description.

TRIGONELLA GLADIATA, *Stev.* (Pl. 5. fig. 78.)

Hypocotyl tapering gradually to the root. Cotyledons on petioles 4 mm. long. (Dimensions in part from Lubbock (1892, p. 414) ; seedlings studied slightly etiolated.)

The structure in seven out of the eight seedlings studied was quite similar to that described for *Medicago tribuloides*. In the eighth seedling, however, the root 2 cm. below the collet was found to be triarch, but in this case also the condition changed to one of tetrarchy 5 mm. below the collet (fig. 78).

Chaveaud (1911, p. 352) also finds a high transition in this species, and gives a figure of the vascular structure at the base of the cotyledon.

TRIGONELLA CRETICA, *Boiss.* (Pl. **1.** fig. 3.)

Erect annual herb. Hypocotyl tapering slowly to the long little-branched primary root. Cotyledon rather thick ; lamina obovate, jointed to a short petiole ; short cotyledonary tube.

The transition phenomena are almost identical with those exhibited by *Medicago lupulina*, both in the change from tri- to tetrarchy and in the level and conformation of the transitional structures.

TRIFOLIUM ARVENSE, *Linn.* (Pl. **1.** fig. 15.)

Hypocotyl passing smoothly into the primary root. Cotyledons ovate, jointed to short petiole ; short one-sided cotyledonary tube.

The transition is closely similar to that in *Medicago lupulina.* The change from triarchy to tetrarchy takes place in some instances 1 or 2 mm. below the collet, in others not till about 2 mm. above the collet. The changes have, however, not quite advanced so far at the node as in *M. lupulina.*

TRIFOLIUM HYBRIDUM, *Linn.*

Hypocotyl tapering slowly to a long primary root. Cotyledons ovate, jointed to short petiole. The smallest seedling studied.

The root is triarch, the number of vessels being very small (about ten). This structure persists about half-way up the hypocotyl ; a small pith then appears, and shortly afterwards a fourth protoxylem in the intercotyledonary plane. Thus at three-quarters of the way up the hypocotyl we have a tiny pith surrounded by a continuous ring of xylem with four protoxylems ; four phloems alternate with the latter. The whole vascular system then divides in half along the minor axis, the V-shaped halves after slight rearrangement entering the cotyledons.

MEDICAGO LUPULINA, *Linn.* (Pl. **5.** figs. 79–81.)

A procumbent much-branched annual or biennial herb. The hypocotyl narrows slowly to a long and little-branched primary root. Cotyledons ovate, moderately thick, green, spreading just above the ground. (Pl. **1.** fig. 1.)

The root is triarch (fig. 79) ; the three equal 1–2-seriate xylem plates meet in the centre of the stele. The phloems contain groups of thick-walled fibres which abut externally on the single-layered parenchymatous pericycle. The endodermis is large-celled, with dots on the radial walls.

At the region of the collet one of the three xylem plates becomes a little weaker than the other two, and the latter increase their angular distance from 120° to 180° (fig. 80). At the same time the phloem between them elongates tangentially and then divides into two. While this is happening, a fourth xylem plate appears, first as a projecting group of metaxylem vessels which then acquire a protoxylem (fig. 81). The base of the hypocotyl is tetrarch, but the polar xylems are better developed than the lateral.

The primary xylem becomes mixed with a little parenchyma and so broken up into detached pieces. No true pith appears, however, until we have ascended about seven-eighths of the hypocotyl, the centre of the stele being occupied by one or two large metaxylem vessels. As we pass up the hypocotyl all the primary xylem vessels become spirally thickened. About 2 mm. below the cotyledonary node a pith appears, and the xylem separates into two V-shaped masses. These gradually contract into pairs of loose xylem groups, joined externally by the polar protoxylem and having the halves of the lateral protoxylem attached internally. In this condition the cotyledon-tube is entered. Here each cotyledon trace consists of a pair of wedge-shaped xylems, with phloems obliquely dorsal to them and with the crushed protoxylem in between.

As the cotyledons become detached the bundles become more collateral and endarch, and fuse together in the median plane, shortly afterwards beginning to branch in a pinnate manner.

MEDICAGO TURBINATA, *Willd.*

Diffuse annual herb. Cotyledons ovate.

The material was unsatisfactory. Triarchy was found in the root, changing to tetrarchy higher up. In the upper part of the hypocotyl the inter-cotyledonary root-poles were absent, the transition being completed on the diarch plan and being high. Thus the comparison appears to be with *Ononis rotundifolia*, at least in some respects.

MEDICAGO FALCATA, *Linn.*

Hypocotyl tapering slowly to the root. Cotyledons ovate, not jointed to the petiole.

The structure of the seedling was investigated by Gérard (1881, p. 349). From his account of the mode of transition the present differs in certain respects. Gérard describes a triarch root of which two xylems are cotyledonary, while the third changes the direction of differentiation from centripetal to centrifugal, acquires phloem, and passes as a collateral stem-like bundle into the first leaf.

In the material described, however, two chief differences were observed from Gérard's account. The root was found to be triarch, but in ascending the hypocotyl there took place changes like those described in *Medicago lupulina*, &c., resulting in the production of a tetrarch symmetry. Further, it was found that the lateral xylems become divided into halves and that these pass out into the cotyledons with the polar xylems, the whole forming a V-shaped group. Thus there is an agreement with other members of the Trifolieæ, in that all the four xylems are cotyledonary; and the exceptional behaviour of the third xylem, according to Gérard, is unconfirmed. It seems probable that Gérard regarded this third xylem as continuous with vessels which are in older seedlings superposed to it, and which are in direct connection with the first-leaf trace.

MEDICAGO SATIVA, *Linn.*, was examined by Van Tieghem (1870, p. 221), who stated (as did Gérard for *M. falcata*, see p. 34) that the cotyledons take two of the xylems of the triarch root, the third xylem entering the first leaf. (This statement he also made for *Hedysarum coronarium* and *Onobrychis sativa*, in both of which the present researches indicate, on the contrary, that all three xylems are cotyledonary; as well as for certain of the Vicieæ, in which the plumular nature of the third root xylem is abundantly confirmed.) Van Tieghem also observed that some main roots of *M. sativa* show four vascular plates, with more or less complete abortion of the fourth; this being evidently the same phenomenon as observed in *M. lupulina*, *M. falcata*, &c.

MELILOTUS ARVENSIS, *Wallr.* (Pls. **1.** fig. 2; **5.** figs. 82–84; **6.** fig. 85.)

Hypocotyl tapers gently into the long primary root. The cotyledons have an ovate lamina, jointed at the base to a petiole 1 mm. long.

The root contains a solid triarch xylem star, with equidistant 1–2-seriate protoxylem rays (fig. 82). The phloem contains fibres. This structure persists for about 5 mm. above the collet; then one of the xylems gradually dwindles (fig. 83), and eventually disappears about half-way up the hypocotyl; the other two xylems straighten into line, and a solid diarch xylem plate is the result (fig. 84). There are, however, *four* groups of phloem with fibres, one of the groups from the root having divided. About 7 mm. below the cotyledons a pith first appears, and the xylem separates into two V-shaped groups; the metaxylems gradually move outwards (fig. 85); and at the node the vascular supply of each cotyledon consists of a tangential row of bundles; in the middle the vestigial protoxylem, on either side of this a wedge-shaped metaxylem group, and on the extremities of the row the phloems. Except for the indication shown by the phloems, there are no signs of tetrarchy in this seedling. Triarchy passes to diarchy by the disappearance of one of the protoxylems, and the upper part of the hypocotyl is constructed on the diarch plan, as in *Ononis rotundifolia* and *Medicago turbinata*.

LOTEÆ.

ANTHYLLIS BARBA-JOVIS, *Linn.*

Small undershrub. Hypocotyl slowly tapering to the root. Cotyledons ovate and leaf-like, without axillary buds

The root contains a diarch 1–2-seriate plate of primary xylem; the phloem includes small scattered groups of large fibres, which die out on entering the hypocotyl. As we ascend the hypocotyl, the xylem plate increases somewhat in thickness at the centre and the protoxylems become crushed, but a pith does not appear till about 4 mm. below the cotyledons. On the appearance of the pith the xylem begins to round up into two polar double bundles, and the phloem divides to accompany each group of xylem. At the node, however, the xylem is still exarch and roughly V-shaped, and the phloems lie laterally to it. Soon after entering the cotyledon, the transitional changes are completed by the gradual change in relative position of the root protoxylem and the metaxylem elements, and by the passage of the phloem into a dorsal position.

ANTHYLLIS VULNERARIA, *Linn.* (Pl. **1.** fig. 12.)

A perennial herb, with short woody root-stock and mainly radical leaves. Hypocotyl passes smoothly into the root. Cotyledons narrowly oblong, connate into a short tube at the base. Lubbock (1892, p. 418) and De Candolle (1825, pl. 5) give figures of the seedling.

The root is diarch, containing a narrow 1–3-seriate band of xylem lying in the cotyledonary plane. The phloem is destitute of fibres. This condition continues for about five-sixths of the way up the hypocotyl, where the transition commences; the details closely resemble those in *A. Barba-Jovis.*

ANTHYLLIS VULNERARIA var. DILLENII, *Schult.*

The seedling agrees closely with the type in form, size, and anatomy, and there is no need to describe it further.

ANTHYLLIS TETRAPHYLLA, *Linn.* (Pl. **6.** fig. 86.)

Hypocotyl tapering slowly to the root. Cotyledons ovate, slightly asymmetrical, stalked with prominent midrib, pinninerved.

The root, unlike that of the other species of *Anthyllis*, is tetrarch, containing a solid four-rayed xylem star and four phloems, each with a central mass of fibres. A pith slowly appears about half-way up the hypocotyl, and gradually separates the xylem into four groups, of which the two polar remain wedge-shaped, the two lateral broadening into a V-shape (fig. 86, at three-quarters up hypocotyl). A little higher up six groups can be distinguished, comprising a polar bundle and two half-lateral bundles at each end of the elliptical stele. The polar xylems undergo rearrangement of elements, becoming double, and are joined by the half-lateral xylems about 2 mm. below the cotyledonary node. The four phloems, each with a central group of fibres, continue unchanged throughout the hypocotyl. The cotyledon trace is composed of a pair of collateral bundles with vestiges of the polar protoxylem directly between them.

HOSACKIA PURSHIANA, *Benth.*

Erect annual. Material much etiolated, so that full dimensions cannot be given.

The root was very short in the nine seedlings examined, and in all cases exhibited four 1–2-seriate xylem plates: triarchy has, however, been recorded by Van Tieghem and Douliot for *Hosackia* (sp. ?), and this may be the case in longer roots of *H. Purshiana.* The transition seems to resemble that of *Anthyllis tetraphylla* in some respects, though the bulk of the tissues is less. The changes, moreover, do not being till two-thirds up the hypocotyl; they are incomplete below the node, and in fact remain so far into the cotyledons, the lateral bundles not becoming truly collateral.

LOTUS TETRAGONOLOBUS, *Linn.*

Prostrate or ascending herb. Hypocotyl tapering very gradually to a long primary root. Cotyledons rather thick, ovate, slightly asymmetrical, conspicuously jointed to a stout petiole of 2 mm., strongly nyctitropic.

The root is tetrarch, containing a solid stout xylem star alternating with four phloems, each with a strong group of fibres. The fibres throughout the seedling are rather conspicuous. This root-like structure persists without change for more than half-way up the hypocotyl. Here, however, there is a slight tendency for the four metaxylem bands to separate, and also for the protoxylems to become detached from their respective metaxylems (a phenomenon also observed elsewhere, *e.g.*, in *Guilandina Bonducella*). As we enter the upper half of the hypocotyl there appears a pith which enlarges rapidly, and causes the lateral xylems to broaden out and finally to divide in half; the polar xylem remaining in compact centripetal bands: thus, three-quarters of the way up the hypocotyl six bundles are present—viz., the two polar and the four half-lateral xylems. Just below the node the polar xylems divide into triads, and are joined by the half-laterals; the phloems remaining in the same position throughout the hypocotyl, with the result that two cotyledon traces are organised, each composed of a median protoxylem and a pair of collateral bundles, one on each side. The transition is therefore best described as "intermediate-high."

The development of the fibres, which though not great is yet more pronounced than in most Loteæ, seems to aid in the support of this tall seedling with its root-like hypocotyledonary structure. It is very unusual to find so high a transition in so thick a hypocotyl.

LOTUS REQUIENI, *Mauri.*

Erect annual herb. Hypocotyl tapering slowly to the root. Cotyledons ovate.

The root is tetrarch, and the whole structure of the hypocotyl very closely resembles that in *L. Tetragonolobus,* save in details. The transition takes place in the same region, and the cotyledon traces are similarly constituted.

There does not seem, however, to be the same tendency for the proto- and metaxylems to become detached from one another; nor are fibres so strongly developed in the phloem.

Lotus corniculatus, *Linn.* (Pl. **1.** fig. 17.)

Hypocotyl passes smoothly into the primary root, which quickly forks. Cotyledons ovate, shortly petiolate.

The xylem of the root is in the form of a solid three-rayed star of small size. The phloem contains no fibres. No change in structure occurs until about 5 mm. below the cotyledons. Here a pith begins to appear: two of the xylem rays increase their angular distance and the phloem between them divides into two groups. The polar xylems eventually become almost opposite; the third (lateral) xylem gradually dwindles and finally becomes almost extinct. No trace of a fourth protoxylem was detected. The cotyledonary trace at the node consists of two small tangential groups of metaxylem with protoxylem between, and of two groups of phloem lying laterally to the metaxylems. The final stages of the transition are accomplished just above the first branching of the cotyledon veins.

Lotus corniculatus has recently been examined by Chauveaud (1911, p. 351), who gives a figure of a transverse section at the base of the cotyledon and a description of the transition phenomena.

Dorycnium hirsutum, *Sér.* (Pl. **6.** figs. 87–89.)

Small bushy plant. Cotyledons ovate, articulated to the short petiole.

The structure of the lower part of the hypocotyl and root is very variable. Out of ten seedlings examined two were found to have a tetrarch root, five a triarch, and three a diarch. The upper part of the hypocotyl, however, shows the same structure, whatever the symmetry of the root.

(i.) The xylem in a tetrarch root consists of four equal biseriate plates of vessels meeting in the centre of the stele. This arrangement continues till nearly half-way up the hypocotyl. A small pith then appears and the xylems in the cotyledonary plane are separated somewhat: as the pith increases the lateral xylems broaden out tangentially, and at the same time their protoxylems become compressed towards the centre. The stele thus becomes elliptical, and the lateral protoxylems lose in importance relatively to the polar: the latter remain narrowly wedge-shaped and conspicuously exarch. The xylem remains in a continuous ring round the pith to within 2 mm. of the cotyledons: then a separation into two cotyledonary traces takes place (fig. 89); and the narrow V-shaped xylems (each composed of a polar group and a pair of attached half-laterals with their protoxylems) quickly collect into the usual type of double bundles.

The exarch position of the polar protoxylem continues into the base of the cotyledons, and the pair of phloem bundles are in a tangential position relatively to the xylem at the node. As we ascend into the cotyledonary lamina, however, the xylem gradually becomes mesarch and then endarch, and the phloems slowly move to the dorsal position.

(ii.) In the triarch type (fig. 87) the three-rayed xylem star persists until nearly half-way up the hypocotyl. Then, as the pith begins to appear, two xylems (the polar ones) gradually increase their angular distance until they become opposite ; the phloem between them divides into two parts, and the metaxylem on the side of the pith opposite to the third xylem acquires a few protoxylem elements (fig. 88). Thus a tetrarch arrangement is produced, and, by the equalisation of the lateral groups of xylem, the structure assumes the same symmetry as is found in seedlings with tetrarch roots (fig. 89, taken from a triarch seedling).

(iii.) The diarch type is a further simplification, and passes into the tetrarch symmetry in the course of the hypocotyl in a mode similar to that pursued in the transformation from triarch into tetrarch. It may be noted that the two missing lateral groups of xylem do not appear simultaneously, but that as we pass up the hypocotyl we find a triarch stage intervening between the diarch and the tetrarch.

Measurements reveal no differences in size between seedlings showing different types of symmetry (cf. *Caragana arborescens*).

GALEGEÆ.

INDIGOFERA GALEGOIDES, *DC.*

Tall shrub. Hypocotyl tapering slowly into the long primary root. Cotyledons ovate-oblong. The hypocotyl is somewhat downy.

The root is tetrarch, the xylem being in a solid four-rayed star 6 mm. below the collet. Here the changes begin ; a pith appears, and the xylem is speedily broken up into four solid equilateral wedges. Fibres and tannin-sacs are present in the phloem. At the collet the four xylems are contiguous, but higher up they separate completely and each becomes radially crushed into a tangential position : the protoxylems projecting outwards slightly.

2 mm. below the cotyledons the lateral xylems divide and the halves go to join the polar groups ; a double bundle is thus formed at each pole of the ellipse, but each of the two bundles composing it is clearly made up of polar and lateral groups. At the departure of the cotyledon the double bundle is practically endarch ; and the transition is completed in the region of branching by fusion in the median plane.

INDIGOFERA TINCTORIA, *Linn.*

Hypocotyl hairy. Cotyledons ovate. De Candolle (1825, pl. 7) gives a figure of a seedling.

Seedlings supplied under the name *I. sumatrana*, Gærtn., agreed closely with *I. tinctoria*, to which species *I. sumatrana* is referred by the Kew Index.

The structure is very similar in both species, and agrees with that described for *I. galegoides* so nearly that further description is unnecessary.

INDIGOFERA sp. (? *I. pulchella*, Roxb., a shrub.)

Cotyledons ovate, leaf-like.

This species also shows a close similarity in structure to *I. galegoides* and other *Indigofera* spp.

TEPHROSIA PURPUREA, *Pers.*

Much branched, sub-erect perennial, 30–60 cm. high. Hypocotyl tapering rather rapidly to the long primary root. Cotyledons oblong, with a notch on one side owing to pressure against the hilum, much furrowed on the ventral surface over the veins. The seedling is clothed with long unicellular hairs.

The root is tetrarch, and 3 mm. below the external collet a solid xylem star is present. The phloem has stout fibres. A pith begins to appear, and at the collet the xylem is spread out into a continuous ring of metaxylem with four projecting protoxylems. The phloem at the collet forms four continuous bands alternating with the protoxylems; each of these contains a conspicuous group of fibres separated from the well-dotted endodermis by a single layer of pericycle, and flanked by sieve-tubes, companion-cells, and phloem parenchyma. 5 mm. above the collet the pith is still larger, and the xylem ring has broken into four similar triads, each consisting of a small effete median protoxylem and two larger tangential metaxylems.

The lateral metaxylems separate gradually, their protoxylems also divide and follow them; 10 mm. below the cotyledons there are present, besides the polar protoxylems, four long tangential bands of metaxylem with vestiges of the lateral half-protoxylems on their intercotyledonary edges.

As we ascend to the cotyledonary node the xylem bundles gradually contract and become endarch, the lateral protoxylems losing their distinctness; the pitted vessels are completely replaced by spiral, and the phloem loses its fibres. The cotyledon trace thus consists of a pair of collateral stem-like bundles with intervening polar protoxylems.

GALEGA ORIENTALIS, *Lam.*

Erect herbaceous perennial. Hypocotyl slowly tapering to the root. Cotyledons long-stalked, spathulate.

The root is tetrarch, four equal xylem plates being present and meeting at the centre. The phloem contains a few large fibres. As we ascend to the collet, two of the protoxylem rays dwindle relatively to the others, and about 4 mm. above the collet they disappear altogether, though their metaxylems persist to some extent; the structure then becomes apparently diarch. A pith begins to appear just above the collet, and by its gradual broadening breaks the xylem into two cotyledonary traces which have a narrow V-shape. The metaxylems collect into two groups on the sides of each polar protoxylem, and the phloems (which have undergone no change save the loss of their fibres at the collet) now lie on the flanks of the double xylem bundle so formed. In this position the vascular tissue enters the cotyledons, and gradually changes, as it ascends the petiole, until the xylem is completely endarch and the two phloems have fused dorsally above it; this happens in the region of branching of the veins.

GALEGA OFFICINALIS, *Linn.*

Erect perennial herb. Cotyledons spathulate-oblong. De Candolle (1825, pl. 8) gives a figure.

The material examined was unsatisfactory, owing to extensive secondary thickening. The structure appeared to show considerable similarity to *G. orientalis.* The root was apparently tetrarch, becoming diarch above, and the transition was high; but the material hardly admitted of complete certainty in the examination of the primary structure.

COLUTEA CRUENTA, *Dryand.*

Fair-sized shrub. Hypocotyl tapering slowly to the long primary root. Cotyledons ovate.

The root is tetrarch, xylem being solid to the centre. A pith begins to appear just below the external collet, and slowly dilates as we ascend the hypocotyl. The xylem arranges itself in four similar tangential groups, each of which carries with it a pair of phloems arisen by the division of the four root-phloems. Not until 2 mm. below the node do the lateral xylem groups divide in half and pass to join the polar xylems; the latter here consist of three groups each, a median protoxylem and two metaxylem wings with superposed phloem. Just below the cotyledons fusion of the half-bundles takes place; and at the node each cotyledon trace consists of two broad collateral bundles, with a conspicuous group of crushed polar protoxylem lying between them, and small patches of lateral protoxylem on their extreme edges.

COLUTEA ARBORESCENS, *Linn.* (Pl. **1**. fig. 14.)

Shrub of 2–3 metres. Base of hypocotyl somewhat swollen beneath the ground and tapering rapidly to root. Cotyledons large, leaf-like, ovate, slightly secund. De Candolle (1825, pl. 11) gives a figure of the seedling.

The transition is essentially similar to that described in *C. cruenta.*

CARAGANA ARBORESCENS, *Lam.* (Pls. **6**. fig. 90; **7**. figs. 91, 92.)

Fair-sized shrub. Hypocotyl passing smoothly into the little-branched primary root. Cotyledons shortly petiolate, oblong-ovate, thick. Lubbock (1892, p. 427) in describing the embryo states that the position of the radicle varies much in different seeds, being "accumbent, or obliquely or wholly incumbent," and being "compressed or subterete according to position." (Pl. **1**. fig. 5.)

The root is tetrarch or triarch, or may show a structure intermediate between typical triarchy and tetrarchy.

(i.) When the root is tetrarch it contains four narrow plates of xylem meeting in the centre, and four equal groups of phloem with fibres. Pith begins to appear 10 mm. below the collet and rapidly increases in bulk, so that the early stages of the transition are passed through before the hypocotyl is reached. At the collet the xylem is arranged in four groups of three, a large median protoxylem and a pair of smaller lateral metaxylems composing each triad. The phloem also divides, and half-bundles go to lie over each metaxylem. As we pass up the hypocotyl the metaxylems gradually increase in bulk and become mixed with parenchyma, while the protoxylems become crushed ; so that half-way up the hypocotyl there are eight main bands of xylem, each with its own group of phloem, thus forming a system of stem-like collateral bundles. The lateral xylems separate in the usual way, and the halves with their phloems join the polar bundles.

The cotyledonary trace consists of a pair of collateral bundles and a few crushed protoxylem elements between.

(ii.) In the case of the seedlings with triarch root the structure and changes of the individual bundles are identical with those which are found in the tetrarch until about half-way up the hypocotyl (Pl. **6**. fig. 90). Then a new small group of vessels appears in the intercotyledonary plane ; this is the representative of the fourth root xylem (Pl. **7**. fig. 91). It is quite unconnected with the other xylem elements, and can hardly function for water-conduction from the root until it is put in communication therewith by secondary developments. It never reaches the size of the other lateral xylem group, but behaves in an exactly similar fashion (fig. 92). The remainder of the transition phenomena are precisely as in the tetrarch type, except that the double bundles of the cotyledon traces are somewhat smaller on the side of the late-appearing fourth xylem than on the other.

(iii.) In the intermediate type (seen in one seedling) the root shows, apparently throughout its length, four groups of xylem of very unequal size and unequally spaced round the stele. One of the xylems is relatively small and consists only of protoxylem, while the others possess metaxylem also ; at the collet, the three others have the usual detached metaxylem wings, while he small lateral xylem is without them. This condition gradually changes to that of the typical tetrarch type as we ascend the hypocotyl, and the main features of the transition are identical with those in case i.

It was found that in triarch seedlings the diameter of the hypocotyl is

1·0–1·1 mm., while in tetrarch it is 1·1–1·2 mm.; it is possible that this variation is connected with the variability in position of the radicle within the testa. So slight is the difference in diameter, however, that it is suggested with hesitation that it may be connected with the variation of symmetry. In *Dorycnium hirsutum*, more variable still in anatomy, no such variation in diameter was detected.

CARAGANA TRAGACANTHOIDES, *Poir.*

Shrub or small tree. Cotyledons ovate, shortly stalked.

The root is triarch in the only seedling examined, becoming tetrarch several mm. below the collet. The xylem is in four narrow wedge-shaped groups, surrounding a pith, which appears to be present throughout. Above the collet the features of the anatomy closely resemble those in *C. arborescens*.

ASTRAGALUS CHLOROSTACHYS, *Lindl.*

A copiously branched undershrub, several feet high. The cotyledons are stalked and twisted to one side, uniting to a short tube which bears the axillary buds.

The root is triarch, containing a small solid xylem star, and three phloems without fibres. A pith begins to appear at the collet region, but dilates slowly, so that not till two-thirds up the hypocotyl do we find the xylem forming the usual complete ring with three projecting protoxylems. In the upper third of the hypocotyl, however, changes are more rapid. The xylem ring breaks in the intercotyledonary plane, and at the same time new protoxylem elements make their appearance on the side opposite the third (lateral) protoxylem. Thus the separating cotyledon traces appear to have been derived from a tetrarch root. The three protoxylem groups—polar and two half-laterals—of each cotyledon bundle are quite conspicuous, and persist above the cotyledonary node. The double bundle at the node consists of obliquely collateral groups of xylem and phloem between which the polar protoxylem persists. The fusion of phloems takes place just above the region of branching into the lamina.

CARMICHAELIA AUSTRALIS, *R. Br.*

An erect almost leafless shrub. Cotyledons stalked, ovate, slightly secund.

The root is triarch, containing three equal 1–2-seriate xylem plates meeting at the centre. These separate and become wedge-shaped, arranging themselves round a pith, so that the two polar xylems are more than 120° apart. A little more than half-way up the hypocotyl the phloem between the polar xylems divides; and about 2 mm. below the cotyledons a fourth xylem appears between the two half-phloems, so that tetrarchy is established.

In the three seedlings examined this new fourth xylem did not divide itself between the two cotyledons, but passed entire to one cotyledon, joining the polar xylem on its way out. It should thus be compared not with a complete root-pole, but with half one. The other intercotyledonary xylem (third) in two seedlings was shared equally between the two cotyledons; in the other seedling it went entire to one cotyledon (the fourth xylem going to the other).

SWAINSONA CADELLI, *F. Muell.* (Pl. **6**. fig. 93.)

The root contains three similar 1–2-seriate xylem plates meeting in the centre. This structure continues some distance into the hypocotyl; the xylems then gradually widen out and a pith appears. Half-way up the hypocotyl the xylem lies in a C-shaped figure of unusual appearance (fig. 93). This continues to within 2 mm. of the node, where the third xylem divides along the minor axis, the halves going in conjunction with the polar xylems to the cotyledons. The cotyledon trace is a lop-sided endarch-mesarch group of xylem with two obliquely-placed phloems; the two cotyledon traces are separated by about 150°.

ASTRAGALUS DANICUS, *Retz.*, var. ALBUS.

A herbaceous perennial with stems 10–30 cm. high. The cotyledons are ovate, on a petiole of fair length: one edge is curved and the other almost straight; it is towards the latter that the first leaf is borne.

The root has a solid triarch xylem star which runs unchanged up the hypocotyl for about 10 mm. A pith then appears, and the vessels themselves become intermingled with parenchyma, their reticulate structure being replaced by spiral. The xylem then divides itself equally between the two ends of the elliptical stele, the lateral group splitting along the minor axis. No signs of a fourth protoxylem group were detected. At the node the xylem is mesarch; the bundles on one side (that of the third root-pole) are slightly larger than those on the other; the phloems are obliquely dorsal to the xylems, and become fused in the median line higher up the cotyledon in the region of branching. The double bundles are not quite opposite at the node, but go off at an angle of about 150°.

OXYTROPIS CAMPESTRIS, *DC.*

A herbaceous perennial with woody root-stock. Hypocotyl passing smoothly into root. Cotyledons ovate, connate at base, slightly turned to one side.

The root has a solid triarch xylem star. The phloem contains fibres. The transition is high, as there is no modification of the root-structure until about 3 mm. below the cotyledons. Then the polar xylems are separated by a pith and the third xylem divides itself between them; no trace of a fourth protoxylem was observed. The cotyledon trace at the node consists of phloems and xylems in a tangential row; but the transition is completed by the bundles becoming collateral very shortly above the node.

OXYTROPIS LAPPONICA, *Gaud.*

A herbaceous perennial, sometimes with stems not developed, at others with stems a few centimetres long. The cotyledons are small and ovate.

The transition phenomena are closely similar to those in *O. campestris*.

BISERRULA PELECINUS, *Linn.*

Many seedlings arise from a long indehiscent fruit. The cotyledons are ovate and leaf-like.

The transition is quite like that in the *Oxytropis* spp.

HEDYSAREÆ.

ARACHIS HYPOGÆA, *Linn.*

A small annual herbaceous plant with diffuse stems producing large seeds which ripen underground. The embryo is straight. The cotyledons are stout and fleshy, ovate with a cordate base; on germination they are pushed up above ground, but serve almost entirely for food-storage. The hypocotyl is short and thick, 7 mm. in diameter at the base, 6×4 mm. at the oval summit, with a marked constriction below the collet leading to the narrower primary root. De Candolle (1825) gives a figure of the seedling.

The root is tetrarch, the xylem consisting of a solid mass of large pitted vessels with four radiating protoxylem arms. The phloems contain a large quantity of scattered fibres. At the dilation of the axis below the external collet a large pith appears; the metaxylem moves into a tangential position and forms wings on either side of the four long narrow 1–3-seriate protoxylem plates. Immediately above the collet the metaxylem wings of the polar groups move tangentially and fuse with the lateral groups; the latter having, with their protoxylems, divided. Thus four main groups of xylem are found at approximately equal distances; over each of these lies a phloem group, so that the axis at this point would have a stem-like structure but for the vestigial polar protoxylem at each end of the elliptical stele.

Plumular bundles now begin to appear; they detach themselves from the four main metaxylem groups laterally to the stele, so that it is difficult to determine whether the lateral root-poles are cotyledonary or plumular. As they appear the ellipse elongates considerably: 2 mm. above the external collet the first plumular bundles are given off; half-way up the hypocotyl there are three on either side. The cotyledon traces have also become more complex, and each consists of the median vestigial protoxylem and four collateral bundles. Higher up still the bundles supplying each cotyledon have again fused into two broad bands, and in this condition they enter the cotyledons; the plumular bundles have increased by branching into five on each side, and just below the cotyledons eight or nine are present on each side of the stele.

DESMODIUM CANADENSE, *DC.*

The hypocotyl gradually tapers to the long primary root. The cotyledons are ovate, slightly secund, and a little thickened.

The root is tetrarch, containing a solid xylem star; a short distance below the collet the xylem breaks into four triangular groups arranged at equal distances round a small pith. Just above the external collet the xylems gradually spread into the tangential position; the phloems divide at the same time; and two-thirds of the way up the hypocotyl the stele contains eight tangential groups of metaxylem with a phloem group superposed upon each. The protoxylems behave in the usual manner; the polar ones remain in the cotyledonary plane, being isolated from their metaxylems; the lateral ones divide shortly after their metaxylems, and pass with them to join the polar metaxylems.

Plumular bundles appear first in the intercotyledonary plane on both sides of the stele simultaneously (the first two leaves being opposite). A conspicuous feature is the presence of tannin-sacs in connection with the plumular traces in the hypocotyl, and their complete absence in connection with the cotyledonary traces, cotyledons, and root. (Tannin-sacs are abundant in the epicotyl, especially in the hypodermal layer and the pericycle.)

The cotyledon trace consists of a median protoxylem and two compound metaxylems, vestiges of the lateral protoxylem remaining on the extreme edge; the phloems have again fused, and two pass out to each cotyledon.

DESMODIUM GANGETICUM, *DC.*

Decumbent or erect herb or undershrub. Cotyledons ovate.

The transition phenomena are on the whole similar to those in *D. canadense*, but take place at a higher level. The small solid root-like xylem star continues half-way up the hypocotyl before being broken into four wedges by the appearance of a pith. At no period, also, are there eight collateral bundles in the hypocotyl, for the lateral half-xylems join the polar groups while the latter is breaking into a triad. Four phloems are present throughout.

SCORPIURUS VERMICULATA, *Linn.* (Pl. **1**. fig. 11.)

The hypocotyl passes smoothly into the little-branched primary root. The cotyledons are linear and of great length, furrowed on the ventral surface, and with membranous connate wings at the base. De Candolle (1825, pl. 12) gives a figure of the seedling.

The root is tetrarch, a solid xylem star with four equidistant protoxylems being present. The phloems contain fibres. The transition is that usual for tetrarch seedlings ; it is initiated at the collet by the appearance of a pith ; the lateral bundles divide about three-quarters of the way up the hypocotyl, and fuse with the halves of the polar bundles. At the node each cotyledon trace consists of a pair of collateral metaxylem bundles with protoxylem between. On entering the cotyledon each of the two bundles forks, the adjacent halves fusing together ; and throughout the cotyledon there run a median endarch collateral bundle and a pair of lateral bundles.

Three or four epicotyledonary branches arise at the node, as well as axillary buds borne on the short cotyledon tube (compare *Coronilla varia*, &c.).

SCORPIURUS SULCATA, *Linn.* (Pl. **8**. figs. 94, 95.)

The hypocotyl slowly tapers into the primary root. The cotyledons are linear.

The root is triarch, this arrangement persisting until just beneath the external collet. In the upper part of the hypocotyl a tetrarch structure obtains; the transition from triarchy to tetrarchy usually occurs at the external collet, but occasionally not until half-way up the hypocotyl.

Just below the collet three equal and equidistant 1–2-seriate xylem plates are present, surrounding a fair-sized pith. In the more usual case, the axis dilates below the collet, one of the phloems divides, and a fourth xylem, unconnected with the others, appears between the two halves (fig. 94). This new xylem gradually increases in size, and the axis slowly takes up a regular symmetry, all the xylems being equidistant (fig. 95). Sometimes, however, the fourth xylem does not appear till half-way up the hypocotyl ; and in this case it arises as a branch from one of the other xylem groups. The difference in the insertion of the fourth xylem in the two cases would seem to be related to its value as a water-channel : in the first case it derives its water-current directly from the absorbing surface of the root ; in the second it is merely an accessory conducting strand.

Whatever the origin of the fourth xylem, the upper half of the hypocotyl has a uniform structure. The polar bundles broaden into a V-shape, remaining exarch. The lateral xylems broaden into the tangential position and divide, half of each moving to each pole and fusing with the polar metaxylems. The phloems suffer no change. Thus at each end of the (now elliptical) stele there is a double bundle, with three protoxylems, one in the middle and one at each extremity, and two phloem groups. Though all the xylem fuses together, just below the cotyledonary node the lateral groups again become free, so that each cotyledon receives a median double bundle of xylem and a pair of lateral groups, the phloems being inserted outside the gaps between median and lateral xylems.

Two or three branches arise at the cotyledonary node without reference to the cotyledons, and their internodes are very short, so that a rosette of leaves is formed.

SCORPIURUS SUBVILLOSA, *Linn.*

Has been investigated in detail by Dangeard (1889, p. 108); it appears to present no noteworthy difference from the other *Scorpiurus* spp. described above. The root is tetrarch as in *S. vermiculatus*, and the transition is high as in *S. sulcata*.

ONOBRYCHIS CAPUT-GALLI, *Lam.*

The hypocotyl is sharply constricted just below the collet, this being connected with (? caused by) the pressure of the clasping carpels of the fruit. The cotyledons are large, slightly thickened, and clearly asymmetrical, one edge being straight, the other curved. Figures are given by De Candolle (1825, pl. 14) and Klebs (1885, p. 608).

The root is triarch, three equal and equidistant xylems surrounding a fair-sized pith. This extends to the collet, where changes begin to occur. Just above the collet (at the constricted part of the hypocotyl) two of the xylems (polar) are seen to be more than 120° apart, the third is becoming V-shaped, and a fourth group is appearing opposite the third; four phloem groups are now present, the one originally between the polar xylems having divided. A quarter of the way up the hypocotyl the stele is elliptical, the two polar xylems are still entire, but the two laterals have divided into pairs of tangential groups. Shortly above, the polar xylems also spread out and divide in half; and three-quarters of the way up the hypocotyl four main groups of xylem are found, each formed by the fusion of adjoining halves of polar and lateral metaxylems. The phloems remain unchanged. Each cotyledon takes two of these collateral bundles with the polar protoxylem between. The transition thus resembles that found in *Scorpiurus sulcata* in the passage from triarchy to tetrarchy, but differs in structural details and in the lower level at which the changes occur.

ORNITHOPUS COMPRESSUS, *Linn.*

Hypocotyl tapering gradually to the root. Cotyledons oblong-ovate, shortly petioled, slightly secund, pinninerved.

The root is triarch, with three equal uniseriate xylem plates meeting in the centre. The transition is high, a pith not appearing till within about 5 mm. of the cotyledonary node. At this level a fourth protoxylem arises on the elongated xylem plate in the intercotyledonary plane and almost at once divides into halves like the third protoxylem. Thus, while the transition is completed on the tetrarch plan the greater part of the hypocotyl is triarch.

CORONILLA MONTANA, *Scop.*

An erect perennial herb. The cotyledons are long-stalked; the lamina is ovate, gradually narrowing to the petiole.

The root, just below the collet, is triarch; in the young state two of the primary xylem plates are continuous and the third lies separate ; but in the older state a solid xylem star is produced, with 120° between each protoxylem. The phloem contains groups of stout fibres.

This root-structure persists for about 17 mm. up the hypocotyl without change. 5 mm. below the cotyledons parenchyma begins to appear in the centre of the xylem star, and just above this two of the xylem plates begin to move apart and to become opposite to one another, the third protoxylem remaining in its former position. At the same time the phloem which lies in the enlarging angle between the (median cotyledonary) protoxylems extends tangentially and splits into two bundles, so that four phloem bundles are now present.

About 2 mm. below the cotyledonary node the third (lateral) xylem divides into two parts, and each half attaches itself to the polar xylem plate, which is now becoming wedge-shaped. The polar protoxylem becomes very feeble and the metaxylem rounds up into two loose groups of spiral vessels at each end of the ellipse. On the inner edge of the two groups of metaxylem on one side of the ellipse there are small crushed protoxylem elements derived from the third root-pole. Similar elements now appear on the other side ; so that just below the cotyledons the structure appears to have been derived from a tetrarch root.

Each cotyledon takes the two bundles of metaxylem with vestiges of the polar protoxylem between, and with the "lateral" half-protoxylems on their adaxial side. These latter are not so much crushed as the polar protoxylems. Two phloems, obliquely dorsal to the metaxylems, pass out to each cotyledon. This condition persists until the lamina is entered.

There is a short cotyledonary tube : no axillary buds are produced.

The plumule contains tannin-sacs, whereas the cotyledons and hypocotyledonary axis are without them.

The fact that the "lateral" protoxylems are much less crushed than the polar seems to indicate that they are differentiated slightly later ; and this is supported by the separation of the third xylem from the other two in the young root : but the study of the early differentiation was not made.

It is noteworthy that the fourth xylem pole is not present as such, but is only represented by a pair of protoxylems corresponding to "half-laterals."

HIPPOCREPIS UNISILIQUOSUS, *Linn.*

The cotyledons are linear and long.

The root is triarch and no fourth protoxylem appears. But just above the level where the third protoxylem divides in half (2 mm. below the node) two other small groups of vessels appear on the opposite side of the ellipse ; their appearance is exactly similar to that of the halves of the third xylem, and they behave in the same way ; there is no doubt that they represent the halves of the fourth root protoxylem, itself never produced. The transition is completed on the tetrarch plan: each cotyledon takes a triad of bundles which gives off lateral veins directly it enters the cotyledon.

The structure is thus similar to that of *Coronilla montana*, but shows the origin of the "fourth" half-xylems rather more clearly.

HEDYSARUM CORONARIUM, *Linn.* (Pl. **8**. figs. 96, 97.)

Hypocotyl broadens upwards, and is somewhat compressed and flattened by the persistent pericarp. Cotyledons orbicular, much turned to one side, inserted on broad tube, pinninerved. The first two leaves are alternate, and not, as De Candolle states (1825, p. 100), opposite, though the internodes are very short. De Candolle (1825, pl. 14) and Lubbock (1892, p. 432) give figures.

The root is triarch, containing three equal 1–2-seriate xylem plates, and having fibres in the phloem. The xylem increases in bulk as we enter the hypocotyl, and half-way up the third (intercotyledonary) xylem divides in two, the opposite phloem doing the same (fig. 96). By the broadening of the polar xylems and the junction with them of the half-laterals, a pair of double bundles is produced: these being of the ordinary type save for the presence of the lateral protoxylems on one edge of each, the collateral bundle to which it is attached being markedly larger than its fellow. In this condition the bundles which have come up from the root enter the broad cotyledonary tube. As the tube becomes free, however, a minute collateral bundle appears *de novo* on the side opposite to that of the third xylem; this bundle promptly divides into two similar halves (fig. 97), which speedily separate from one another and anastomose with the double bundles. It is quite clear that this new bundle represents a fourth root xylem, whose appearance is here delayed until the cotyledonary tube is free from the axis.

ONOBRYCHIS SATIVA, *Lam.* (Pl. **1**. fig. 4.)

A perennial herb, with woody root-stock and stout ascending stems. The hypocotyl quickly narrows to the root, being sharply constricted at the collet region by the valves of the persistent fruit. The cotyledons are oblong-ovate, slightly secund, one edge being curved more than the other, moderately thick.

The root xylem is triarch and the phloem contains fibres. The first changes occur in the region of dilation at the external collet. The xylems spread out internally and soon assume a tangential position, the edges of adjacent metaxylems uniting to form a continuous ring round the small pith. As we ascend into the hypocotyl the pith dilates, but the xylem ring remains closed. In the hypocotyl a gradual increase of the pith occurs at the expense of the cortex. The three xylem groups become distinct, and one of them divides into two parts, which go to join the other (polar) xylem groups on their way to the cotyledons. These latter xylems never become opposite, however, and there is nowhere any trace of a tetrarch symmetry. The double bundles are organised in the usual way, but the collateral bundles of each are markedly asymmetrical: the one on the side of, and partially derived from, the third (intercotyledonary) root-pole is much larger than the other. The cotyledons are inserted at less than 180° apart, and their less curved edges are on the side of the third root protoxylem. This is the side on which the first plumular leaf appears; and its trace is represented in the hypocotyl by secondary vascular tissue overlying, but distinct from, the third primary xylem.

Hippocrepis comosa, *Linn.*

A sprawling perennial with a woody root-stock. The cotyledons are almost linear, broadening slightly towards the tips.

The root contains a solid triarch xylem star; the phloems contain fibres, which are present in considerable quantity throughout the seedling; in the hypocotyl, in addition to the phloem fibres, a group of fibres appears opposite each of the three protoxylems and the position of the missing fourth. The vascular tissues are rearranged half-way up the hypocotyl, as if becoming tetrarch, the phloem between the two polar xylems dividing; but no fourth protoxylem appears. Each cotyledon receives one and a half root xylems; the groups of fibres outside the polar protoxylems are confined to the hypocotyl and die out below the node. The transition is typically high.

Coronilla varia, *Linn.*

A diffuse herbaceous perennial. The cotyledons are lanceolate.

The root is triarch; the xylem being solid to the centre, which is usually occupied by a large pitted vessel. The phloem contains fibres. Root-structure continues unchanged through three-quarters of the hypocotyl. A pith then appears and two of the protoxylems become opposite, the third being placed 90° from them. No trace of a fourth protoxylem was found at any level. At the cotyledonary node each double bundle consists of a pair of xylems with a polar protoxylem between and two phloems obliquely dorsal to them.

The epicotyl consists at first of two stems, each with its own leaf-system, borne without special relation to the position of the cotyledons. This behaviour does not affect the primary structure of the hypocotyl. Similar features are found in other Hedysareæ, e. g. *Scorpiurus vermiculatus.*

DALBERGIEÆ.

Dalbergia Sissoo, *Roxb.*

An erect tree. Hypocotyl narrowing gradually to the root. Cotyledons ovate.

The root is tetrarch, containing a solid and almost square xylem. A pith appears some distance below the collet, and the xylem, at first annular, becomes broken into detached pieces at the collet. There are produced four groups of metaxylem which rapidly become endarch, one under each phloem; the two polar protoxylems remain *in situ*. In the upper half of the mature hypocotyl the polar protoxylems disappear completely, and the structure becomes absolutely stem-like. Each cotyledon takes two of the collateral bundles.

DERRIS SCANDENS, *Benth.*

A tall liane. The hypocotyl tapers to a long primary root. The cotyledons are ovate, asymmetrical, and foliaceous.

The root contains a solid tetrarch xylem star and four phloems with included fibres. A pith appears 2 mm. below the collet, and at the collet it has dilated so as to break up the xylem ring into four tangential bands, each with central protoxylem (cf. *Bauhinia*, Pl. **3**. fig. 43, &c.). Intercalated bundles of metaxylem also may appear between adjoining bands of root xylem: these are similar to the "Zwischenstränge" found so frequently in the Phaseoleæ (Dodel, 1869). The polar xylems remain in continuous tangential bands, without showing the division into triads, in the lower half of the hypocotyl. The intercotyledonary xylems divide in halves about half-way up the hypocotyl, and three-quarters of the way up the polar xylems do likewise: the adjoining halves of polar and lateral xylems, however, do not fuse with one another, but pass into the cotyledons separately; each cotyledon thus receiving four xylem bundles as well as intercalary bundles. Meanwhile the phloem, originally in four distinct groups in the root, fuses into an almost continuous ring half-way up the hypocotyl; higher up it again separates, and at the node each cotyledon receives one band of phloem over the two polar half-xylems, and one band over each of the two half-laterals, besides a band over each "Zwischenstrang" when present. The bundles of the cotyledon trace tend to come into contact with one another at the node, but do not actually fuse.

VICIEÆ.

The seedling structure of the Vicieæ has received a good deal of attention in the past: in fact it appears that they have been regarded as representative of the Leguminosæ as a whole, rather to the exclusion of other tribes. Mlle. Goldsmith (1876, p. 1) gave a very complete account of the anatomy of *Vicia sativa*. Gérard (1881, p. 351) examined the structure of *Lathyrus odoratus*, *L. latifolius*, and *Ervum Lens*: these he found to agree substantially with *Vicia sativa*, while differing in certain respects, particularly in the presence of a pith at the cotyledonary node, obliterated higher up; but he placed a different interpretation upon the occurrence of medullary xylem in the first few internodes from that given by Goldsmith. In 1910 Tourneux published a somewhat incomplete account of *Vicia sativa*, *Ervum Lens*, *Pisum* *sativum*, and a species of *Lathyrus*; while adding no new facts of importance he propounded a novel view of the nature of the medullary xylem in the epicotyl. Chauveaud (1911, p. 341) studied *Lathyrus odoratus*, paying much attention to the details of development of the vascular system, and also *Ervum Lens* and *Vicia Faba*.

My own researches and a study of the literature have shown that, with very few exceptions, the seedling structure is very uniform throughout the Vicieæ, the chief differences being in relation to size. In the majority of cases, therefore, I have no new facts to record. A detailed description, however, will be given of the structure of *Pisum sativum* and *Vicia Faba*, in which species certain fresh points of interest have been observed; and other species will be mentioned very briefly.

PISUM SATIVUM, *Linn.* (Pls. **1.** fig. 10; **8.** fig. 105; **9.** figs. 98–104.)

A tall herbaceous annual, climbing by leaf-tendrils. The hypocotyl is very short, the change of epidermis taking place a few mm. beneath the cotyledons. The cotyledons remain in the testa below ground; they are inserted at less than a right angle from one another, and lie laterally to the direct course of the axis. The epicotyl bears two or three trifid bracts and then the foliage-leaves; the arrangement of leaves is distichous and the stem is quadrangular. The main shoot has comparatively short internodes and usually dies after a time, the growth being continued by branches with longer internodes, which arise in the axils of the lowest bracts or leaves. The diameter of the stem just above the ground is much less than in the upper internodes *.

The root is triarch; the xylem is made up of three long and massive radial plates of small elements, which do not extend to the centre, but are connected into a solid xylem star by larger metaxylem elements. There are three groups of strong fibres in the phloem. The endodermis is conspicuously dotted.

As we pass up into the hypocotyl the xylem loses its regular appearance, the radial plates becoming loose groups with a mesarch development; the central metaxylem begins to move outwards and parenchyma appears in its place. The three phloem bundles begin to divide, each separating into two groups. At the same time the two primary xylems destined to supply the cotyledons increase their angular distance and begin to move outwards. Just below the cotyledons the xylem consists of two cotyledon traces and a first-leaf trace, all mesarch and similar in appearance; and three tangential bands of metaxylem, which connect the cotyledon and leaf-traces and surround the fair-sized pith (Pl. **9.** fig. 98).

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* The small diameter of the base of the stem when compared with the size of the aerial system is strikingly shown in the fasciated monstrosity known as the Mummy Pea.

Each cotyledon double xylem bundle carries with it a pair of phloem groups with fibres, these having arisen from the halves of the adjoining root phloems. The remaining halves on the side of the axis away from the cotyledons move tangentially and fuse in the intercotyledonary plane over the first-leaf trace. Before departure each cotyledonary phloem bundle gives off another branch inwards (Pl. **9**. fig. 99). The branches between the cotyledons divide into several groups ; the innermost fuse in the intercotyledonary plane and become the median phloem of the second-leaf trace : the two outermost attach themselves to small groups of xylem given off from the neighbouring metaxylem group, and pass up into the epicotyl as the cortical fibrovascular bundles : the intermediate pair increase much in size and become lateral phloem bundles of the epicotyl. The branches on the side away from the cotyledons suffer no further division but become lateral bundles of the epicotyl also (fig. 100).

Meanwhile the protoxylem of the second-leaf trace appears at the node, being inserted on the same side as the cotyledons. Its exact position may vary. In one instance it was seen to appear in a position external to the intercotyledonary metaxylem, and to move inwards gradually until it became continuous with, and on the inner side of, the metaxylem (figs. 99–101). In other cases it originated in the position it finally occupied.

The metaxylems now suffer a rearrangement : the one in the intercotyledonary plane bends round the end of the ellipse (fig. 101) and breaks into two lateral bundles, the other two remaining in the same position. Then the xylem on each side of the ellipse fuses into a long band (fig. 102) and the two bands become compressed towards the major axis, where they fuse and obliterate the pith. A central mass of xylem is thus produced some few mm. up the epicotyl (fig. 103).

The median bundle of the first leaf gives off a fibre bundle, which breaks through the (still dotted) endodermis, and places itself in the cortex ; shortly afterwards the second-leaf trace does the same (fig. 102).

About half-way up the epicotyledonary internode, therefore, we find the usual four cortical bundles, two fibrous and two fibrovascular ; and within the endodermis two polar fibrovascular bundles, a central dumb-bell-shaped mass of xylem, and four lateral groups of phloem with fibres * (fig. 103).

At the departure of the first leaf (a trifid bract) the median leaf trace passes out and joins the cortical fibre bundle; simultaneously each cortical fibrovascular bundle gives off a branch which becomes a lateral strand of the bract (fig. 104). The vascular system of the bract thus consists of a median and two lateral fibrovascular bundles, which anastomose with one another after its departure.

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* Hérail (1885, p. 219) calls the fibres pericyclic, but the point is difficult to determine. No "typical" phloem intervenes between them and the parenchymatous pericycle : two layers of the latter lie between the central fibres and the endodermis, *i. e.* the same amount as lies between the "typical" phloem and the endodermis.

The xylem of the first-leaf trace has a double appearance, not shared by the phloem ; this reflecting its origin from one of the root xylem poles (cf. *Cæsalpinia sepiaria*).

The medullary xylem at the same time breaks along the minor axis into two pieces, and the piece on the side of the bract splits longitudinally; so that two bundles are produced, each corresponding to one of the lateral phloems (Pls. **9.** fig. 104; **8.** fig. 105). These bundles give off, towards the apex of the ellipse, branches which fuse on the major axis and so reform the polar bundle (connecting with the third leaf). At the same time each of these "faisceaux réparateurs" gives off a group of fibres which fuse in the median plane in the cortex (fig. 104, arrows).

At the second node the medullary xylem left at the other end of the ellipse splits longitudinally and repeats the process. Thus in the third internode a typical medullated stem-structure is produced, and this persists throughout the higher internodes.

There is a certain amount of variation in the arrangement of the vascular strands in the epicotyl. The medullary xylem may never show the complete fusion into a solid core described above, but after the preliminary tangential fusion into two bands may break up again into four groups. The lateral phloem groups often fuse with one another, so that instead of four there may be only three or two such groups within the endodermis.

DIAGRAMS. (Pl. **9.** figs. 98–104.)

Cotyledonary xylem, solid black; phloem, dotted. Plumular protoxylem, cross-hatched; metaxylem, line-shaded; phloem, clear.

x=xylem.
ph=phloem.
frb=fibrovascular bundle.
fb=fibre bundle.
p=plumular.
c=cortical.
C i. & C ii.=the two cotyledons.
L i. & L ii.=the first and second leaves.

98→104: collet → first epicotyledonary node.

VICIA FABA, *Linn.* (Pls. **1.** fig. 9; **8.** figs. 106–108.)

Erect annual, not climbing; the diameter of the stem is greater than in the climbing Vicieæ. There is practically no hypocotyl, the root-like surface extending to immediately below the cotyledons. The main root is long and is much branched at the base, just beneath the cotyledons. The sharply quadrangular epicotyl develops early, and bears as usual two or three trifid bracts and then the large foliage-leaves, their arrangement being distichous in the intercotyledonary plane.

The first epicotyledonary internode shows a different structure from that found in *Pisum sativum* and the climbing Vicieæ generally. A pith is present throughout, the arrangement of bundles in a ring being of the normal type, and there being no medullary xylem; the usual cortical bundles are present, however. In fact, the structure is similar to that which is found in the higher internodes of *Pisum sativum*, where the stem has increased in diameter and the pith is permanent.

The structure of tetrarch seedlings of *Vicia Faba* has been shortly described by Chauveaud (1911, p. 350), who mentions the two cotyledonary and two plumular xylems, and also the medullation of the first epicotyledonary internode.

The structure of the hypocotyledonary axis varies in different specimens. The number of xylem poles in the root may be four, five, or six. Five seems to be the commonest number. A seedling with the tetrarch root will be first described.

(1) There are in the root four xylem plates each consisting of 2–3 rows of vessels, arranged radially around a fair-sized pith which extends to the root apex. Alternating with these are four groups of phloem, which consist, in the upper part of the root, of a central mass of stout fibres, encircled by a ring of clear-celled parenchyma, this again being surrounded by patches of sieve-tubes and companion-cells.

As we ascend the axis, through its region of gradual dilation below the cotyledons, the xylem plates broaden internally and the pith increases in size. The stele becomes somewhat elliptical, and the xylems on the minor axis spread out almost tangentially, and each tends to break into three groups—a median group containing the protoxylem and some metaxylem, and two lateral metaxylem groups. The median groups suffer a re-arrangement of their elements and gradually become endarch, the change being much the same as that which occurs in a cotyledon trace in the region of transition ; in the endarch position these median bundles of the triads enter the epicotyl. The lateral metaxylems also enter the epicotyl without undergoing much change. The median bundles retain signs of a double structure for some time, and become the midrib bundles of the first two leaves respectively, which lie in the intercotyledonary plane. The lateral metaxylems become the lateral " faisceaux réparateurs " of the first epicotyledonary internode.

To return to the xylem bundles which lie on the major axis of the elliptical stele below the cotyledons. They quickly assume a mesarch arrangement, owing to the development of the metaxylem on the flanks of the protoxylem instead of internally to it ; at the same time the metaxylem becomes mixed with parenchyma and comes to consist of spiral vessels only. In the mesarch condition the double bundles pass out to the cotyledons.

The phloem bundles with their contained fibres give off branches below the cotyledons, and each cotyledonary double xylem bundle takes with it portions of the two adjoining phloems. The portions that remain behind give off branches in the opposite directions, which fuse in the intercotyledonary plane dorsally to the median leaf trace xylem bundles ; the residual bundles become the lateral pairs of phloems of the epicotyledonary central stele, one of them lying dorsally to each of the " faisceaux réparateurs."

The cortical fibrovascular bundles of the epicotyl take their origin from the edges of the gap left in the ring of vascular tissue by the departing cotyledon bundles.

We thus see that of the four primary xylem poles of the main root two supply the cotyledons, and two are direct prolongations of the vascular system of the first two epicotyledonary leaves (Pl. **8**. fig. 106).

(2) Seedlings with pentarch roots are very frequent, and the details of transition differ in some respects from those in the tetrarch cases. The five xylems are at first equidistant; as we ascend the root where it dilates one of the xylems gradually dwindles, the protoxylem disappearing altogether, and the metaxylem becoming attached to the neighbouring xylem which is destined to supply one of the cotyledons. So that, so far as the xylem is concerned, the difference from the tetrarch type is not profound. The phloems, five in number, also suffer slightly different changes, which are best represented by a diagram (fig. 107). The difference from the tetrarch type is simply the presence of two phloem bundles (one cotyledonary, one plumular) instead of a single bundle which later divides.

Thus the pentarch type may be regarded as a tetrarch type with intercalation of an extra xylem pole, arising from one of the cotyledonary bundles, and keeping distinct two of the phloem groups which in the tetrarch type fuse into a single group.

(3) In a hexarch seedling the same process is repeated at both poles of the ellipse as occurs in one pole only of the pentarch type. Two supernumerary bundles are present, both on the same side of the stele, and as we ascend into the hypocotyl these fuse with their respective median cotyledonary bundles. The phloems are correspondingly modified (fig. 108). The condition of the vascular tissue at the cotyledonary node is essentially similar in tetrarch, pentarch, and hexarch types.

The relation of the three types of structures here described to one another is shown in figs. 106–108. (Cotyledonary xylem, cross-hatched; phloem, dotted: plumular xylem, line-shaded; phloem, clear: protoxylems which reach the cotyledonary node, black.)

ABRUS PRECATORIUS, *Linn.*

A much-branched climbing shrub. The seedling is very distinct in form from that of the other Vicieæ, and is rather comparable with certain Phaseoleæ (e.g. *Phaseolus radiatus*). The hypocotyl is elongated; the cotyledons are thick and ovate, turning green in the light, with intercotyledonary fused stipules.

The structure has been examined by Dangeard (1889, p. 111), who mentions shortly that "la tigelle est longue [*i. e.* the transition is low] et les huit traces cotylédonnaires restent longtemps distinctes," following them downwards; the root is tetrarch. My own examination of this species confirms these statements; the following additional details may be given.

The four phloem bundles of the root pass up the hypocotyl unaltered, except histologically; fibres are present in the root, but die out higher up. The four root xylems broaden out below the collet into tangential bands, each with a median protoxylem; each of these quickly breaks into two halves, differentiated tangentially, with marginal protoxylem, so that eight xylem bands are produced at the base of the hypocotyl. This continues through about three-quarters of the hypocotyl, the xylems becoming more and more endarch; the groups then come into contact with one another in pairs beneath the phloems, so that four collateral bundles are produced in the upper quarter of the hypocotyl; each bundle, however, showing signs of its double origin. Each cotyledon receives two of these collateral bundles. The plumular bundles are attached to the edges of the cotyledonary bundles towards the minor axis; two such appear on each side about three-quarters up the hypocotyl, and a little higher a median bundle also appears on each side of the minor axis.

The whole structure recalls what is found in the Phaseoleæ, with which tribe this species shows some analogy. Further points of similarity are: (1) the presence in some hypocotyls of intercalary bundles ("Zwischenstränge" of Dodel); (2) the presence of a considerable quantity of tannin in special sacs; (3) the opposite position of the first two leaves; and (4) the early development of the plumule.

Pisum Jomardi shows a very similar structure to that of *P. sativum*; the first epicotyledonary internode, however, has only a single group of fibres on each side of the central elliptical cylinder, instead of the two in *P. sativum*.

Vicia amphicarpæa, *Ervum Lens* *, *Lathyrus angustifolius*, *Orobus cyaneus*, and *O. niger* all show a close resemblance to *Vicia sativa* † (Goldsmith, 1876 p. 1). So also does *Lathyrus Nissolia* ‡, except for its very small size and the consequent restricted number of its vascular elements.

Lathyrus sativus is closely similar to *Pisum sativum*, allowing for its smaller size; the cotyledon traces, however, on their way out through the cortex, give off several small bundles. Many of these disappear almost immediately (*cf.* Van Tieghem, 1884, p. 134); but in several instances one, in a single specimen two bundles from each cotyledon trace pass up the first epicotyledonary internode as cortical fibrovascular bundles.

PHASEOLEÆ.

KENNEDYA RUBICUNDA, *Vent.*

The hypocotyl is curiously thickened at the base, and narrows rapidly upwards: it tapers rather suddenly to a branched primary root. The cotyledons are oblong, pinnately nerved. First two leaves opposite, as is general throughout the Phaseoleæ.

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* Pl. **1.** fig. 6. † Pl. **1.** fig 8. ‡ Pl. **1.** fig. 13.

The root is tetrarch, containing a solid, almost square mass of xylem with slighly projecting protoxylem angles. A pith begins to appear at the collet, and slowly breaks the xylem into four 1-2-seriate plates. These slowly broaden inwardly, and become first Y-shaped, then T-shaped. About 2 mm. below the node the polar xylems break into triads and the lateral xylems divide in half; at the node the adjoining bundles fuse into pairs; so that the cotyledonary trace consists of a median protoxylem and a pair of loose collateral bundles, which are soon resolved into their components on entering the lamina. The transition is thus typically "intermediate."

No fibres are found in the phloem of the seedling; tannin-sacs are conspicuous objects in the hypocotyl.

KENNEDYA RETUSA, *F. Muell.*

A woody climber. The hypocotyl is remarkably thickened in its lower part, and narrows rather suddenly about half-way up; it is constricted at the collet, the root being slender and much branched. The cotyledons are oblong, rather thick, pinninerved.

The transition phenomena show much similarity to those described for *K. rubicunda*, and need not be further considered.

CLITOREA TERNATEA, *Linn.*

A climbing undershrub. The cotyledons often remain long enclosed in the testa, large, thick but foliaceous, oblong, with a cordate base, slightly asymmetrical owing to folding in seed. The hypocotyl gradually tapers to a long, much-branched primary root. Scattered hairs are borne by the hypocotyl, these having a single transverse wall and a recurved pointed tip. Lubbock (1892, p. 441) gives a figure of the seedling, and De Candolle (1825, pl. 9) gives figures of a series of stages in its development.

The root is tetrarch and has a central pith far below the region of the collet. At the collet region there are four protoxylem poles connected by bridges of metaxylem which form an almost continuous ring round the pith. The phloems contain each a group of fibres. The endodermis is fairly distinct, but is not dotted.

As we pass up the hypocotyl the xylem tends to break up into groups, until half-way up the hypocotyl each xylem quadrant is represented by three groups, a median protoxylem and two lateral metaxylems. Alternating with the protoxylem are four long strips of phloem, bounded by pericyclic fibres which abut directly on the well-marked starch-sheath. The xylem also contains many fibres. Higher up the hypocotyl the four root protoxylems also divide and the halves join their respective metaxylems. There are thus produced eight bundles of xylem, fairly evenly distributed round the stele. Each cotyledon receives four of these bundles, which approach one another in pairs and pass out without further change; two long bands of phloem also enter each cotyledon.

SOJA HISPIDA, *Moench.*

The hypocotyl narrows gradually to the root. The cotyledons are ovate and rather fleshy.

The root contains a solid tetrarch xylem star, which begins to contain a central pith just below the external collet. The pith dilates rather rapidly, so that about a quarter of the way up the hypocotyl the xylem is in four spreading groups, with protoxylem in the middle of each. Half-way up the hypocotyl the stele is somewhat elliptical and the two cotyledonary groups of bundles are now distinct: each comprises a polar triad consisting of a median protoxylem and a pair of rather widely separated metaxylem wings; also two halves of the lateral xylems, each consisting of metaxylem with a protoxylem group attached to its extreme edge. The phloem is still in four groups which extend in arcs between the ends of the major and minor axes.

As we ascend above this level the polar protoxylems also divide, and the halves attach themselves to their respective metaxylems. The lateral xylems fuse with the polar a few millimetres below the cotyledons; so that the stele now contains only four broad bands of xylem, of loose texture, consisting chiefly of spiral elements, and having the vestiges of the root protoxylems attached to their edges. These xylem bands gradually become endarch, and by the time the cotyledonary node is reached they are typical stem-like collateral bundles, with hardly a trace of their hypocotyledonary nature. Each cotyledon takes two of these collateral bundles, the median line being devoid of vascular tissue.

GLYCINE HISPIDA, *Maxim.*

The dimensions of the seedling are somewhat larger than in that of *Soja hispida*, of which this species is supposed to be a cultivated variety. The transition phenomena are much alike in both species, but the changes occur at a lower level in *Glycine hispida*; the transition being perhaps best classified as low, though it is not so low as in the Phaseolinæ and Diocleinæ to be described below.

PACHYRRHIZUS ANGULATUS, *Rich.*

The root is tetrarch, and the transition phenomena seem to be quite comparable with those which occur in *Clitorea Ternatea*, for instance, though, as the germination is hypogeal, the changes in the hypocotyl are much compressed.

PHASEOLUS RADIATUS, *Linn.*

An erect biennial. The hypocotyl slowly tapers downwards to the long primary root; in its upper part it is covered with long unicellular hairs, mixed with some club-shaped multicellular hydathodes. The cotyledons are fleshy, green, oblong.

The transition resembles that of *Abrus precatorius* rather closely. It is essentially similar in nature to that found in other Phaseolinæ. Intercalary bundles, however, are not present. Tannin-sacs are frequent, and many of the primary vessels while still young contain a tannin-like substance.

PHASEOLUS HERNANDESII, *Savi.* (Pl. 8. fig. 109.)

A tall climbing annual. The hypocotyl is long and stout. The cotyledons are thick and fleshy, not foliaceous, and are slightly green, but clearly far more for storage than for assimilation. They fall off early and the epicotyl develops rapidly. The primary root is not long, but bears a great number of lateral rootlets just below the region of the external collet. The hypocotyl is sparsely covered with hooked unicellular hairs.

The primary root is tetrarch, showing a solid four-pointed xylem core. Rapid dilation occurs below the external collet, this being caused by the appearance of a pith and its rapid increase in diameter as we pass upwards. At the collet four widely separated groups of primary xylem are found, the metaxylem being arranged in the tangential position: these surround a bulky pith. Even at an early stage of growth a considerable quantity of secondary xylem and phloem is found in the region of the collet, so that the pith is completely surrounded with xylem.

As we pass up the hypocotyl the amount of secondary tissue rapidly diminishes, and 2 cm. above the collet very little is present. The positions of the xylem poles of the root are marked by four disorganised protoxylems. On either side of each of these, and separated from it by some little distance, is a tangential group of metaxylem; there are therefore eight of these groups, which are in direct connection with the metaxylem at the collet. In between adjoining metaxylems are found intercalated xylem bundles, four in number, which connect on with the ring of secondary xylem at the collet region: these are the "Zwischenstränge" of Dodel (1872, p. 156).

Half-way up the hypocotyl the protoxylems from the root have divided and each of the corresponding tangential metaxylems is now edged by a few crushed spiral vessels. The intercalary bundles are now becoming much smaller. The xylem lies embedded in a perimedullary zone of dark-walled cells. The phloem is in four long bands, being interrupted in the planes of the xylem poles of the root: it consists, as in other Phaseoleæ, of small patches of sieve-tubes and companion-cells, many large tannin-sacs and phloem parenchyma.

This condition lasts to within a few millimetres of the cotyledonary node, but the amount of xylem diminishes slowly.

The lateral pairs of xylem strands become more widely separated, and a fusion is effected between adjoining polar and lateral bundles; the cotyledon trace consists of a pair of large collateral bundles, the xylem being composed of a great number of scattered spiral vessels; each bundle being formed by the union of a half-polar and a half-lateral xylem group, with sometimes one or more intercalary bundles.

The bundles supplying each primordial leaf are two in number below the node, being attached to the edges of the cotyledon traces; they gradually approach one another, and finally fuse in the intercotyledonary plane. The bundle thus formed is the midrib of the primordial leaf; it long shows indication of its double origin (fig. 109). Four other large bundles and six small ones are also found in the first epicotyledonary internode.

The rapid development of secondary tissues near the collet is very striking in this species and in other Phaseoleæ, though it is found to some extent in many seedlings; it is clearly correlated with the early development of an extensive and much-branched root-system in the collet region. The main plumular bundles are early brought into relation with this system, and the collet xylem ring may be regarded as the main distributing centre of the young plant. Its development seems to be precocious so far as the aerial parts are concerned; and it may be regarded as dependent on the rapid early growth of the root-system, and as anticipatory of the relatively faster epicotyledonary development to follow.

CANAVALIA ENSIFORMIS, *DC.*

C. GLADIATA, *DC.*

Two species which only differ, in the stages observed, in the former having a red, the latter a white, testa. Large twining biennial or perennial herbs. The large hypocotyl narrows abruptly at the collet and bears a considerable tuft of lateral roots. The cotyledons are large and fleshy, ovate, green. The epicotyl bears the usual pair of primordial leaves with interpetiolar fused stipules.

Much of the structure resembles that of the large *Phaseolus* spp., e.g. *P. Hernandesii.* There are certain differences, however, which must be mentioned.

The root contains a pith far below the collet, there being four radiating biseriate protoxylems, each with a pair of tangential metaxylem wings which unite to form a complete ring. There are no tannin-sacs in any part of the seedling, this being a striking difference from other Phaseoleæ. For the rest the description of *Phaseolus Hernandesii* will apply equally well to these species.

Erythrina indica, *Lam.*

The hypocotyl narrows rapidly to a long tap-root. The cotyledons are ovate and very fleshy.

Only one seedling was available. This showed a heptarch root, seven equal wedge-shaped xylems being arranged round a very large pith. Division of each xylem into a triad takes place below the collet, and collateral bundles with endarch xylem are rapidly formed from pairs of half-xylems beneath each phloem. Apparently three and a half root-poles contribute to each cotyledon; but the point was very difficult to determine accurately, owing to the complexity of the structure, secondary thickening, and abundant tannin.

Erythrina arborescens, *Roxb.*

A low tree. The hypocotyl is short and stout, tapering slowly to a long root, which is much branched. Cotyledons large and fleshy, turning slightly green in the light. Epicotyl tapering upwards, bearing a pair of opposite *Phaseolus*-like leaves.

3 cm. below the node the root (in the one seedling available) is hexarch, but higher up it becomes heptarch. A pith is present throughout. The transition phenomena appear to be quite similar to those of the epigeal *E. indica*, but were extremely difficult to determine.

Voandzeia subterranea, *Thou.* (Pl. 8. figs. 110, 111.)

An annual creeping herb of rapid growth, with very large seeds which ripen underground. Germination is hypogeal. Consequently the hypocotyl is very short—about 10 mm.; the diameter along the major axis (it is elliptical in section) increases from 2·5 mm. at the collet to 6 mm. at the cotyledonary node. The hypocotyl tapers gradually to a long and little-branched primary root. The cotyledons remain enclosed in the testa below ground, and the plumule develops very early, as is usual in hypogeal species. The epicotyl bears a pair of opposite primordial leaves at about 1 cm. above the cotyledonary node.

The number and behaviour of the vascular strands vary to some extent in different specimens. The root has normally more than four primary xylem groups. A seedling with a heptarch root will first be described, and then one with a pentarch root.

(i.) The long primary root shows seven practically equal wedge-shaped groups of primary xylem which are arranged round a fair-sized pith. This condition continues as far as the external collet, though the pith dilates considerably, both here and in the hypocotyl.

At the collet there are eight groups of primary xylem, the new group having arisen by budding off from an old one. The stele becomes elliptical here, and the eight groups arrange themselves so that there are three contiguous ones at each end of the major axis and one separated group at each end of the minor axis.

At the base of the hypocotyl a ninth xylem appears, being budded off from one of the polar groups; the other polar group appears to be about to bud off a tenth xylem, but this does not actually happen. Each of the nine groups now broadens inwardly, becoming somewhat V-shaped. As we pass up the hypocotyl the xylem groups become more and more spread out tangentially; so that at the top of the hypocotyl, just beneath the cotyledons, the xylem tissue consists of two long bands arching round the ends of the ellipse, and mesarch to endarch in development, and a lateral triad of xylem groups on each side of the ellipse. The polar groups become almost completely endarch and pass out bodily into the cotyledons. The lateral groups go straight up into the epicotyl and become the median strands of the primordial leaves. Other small intercalary bundles from the epicotyl also appear at the cotyledonary node, being inserted on the cotyledon traces.

The cotyledons remain lateral to the main axis of the seedling, being twisted to one side at their short stalks, much as in the Vicieæ. The vascular tissue on entering the cotyledon immediately gives off a downward branch, the main mass of the trace forming the midrib.

(ii.) In the second seedling a quite different condition of the vascular strands was found. The main root was found to be pentarch throughout, there being five long radial 2–3-seriate plates of primary xylem surrounding a fair-sized pith. As we pass up the main root into the hypocotyl each of the five xylem groups spreads out tangentially as in seedling No. i.; the size of the individual groups varies much, however, and there is no sign of the grouping into polar cotyledonary traces of the kind in the previous seedling. Each xylem divides into two halves, and rearrangement takes place, the result being that at the node each cotyledon takes one whole root-pole and half of each of the adjoining ones; two half-bundles are left over in this process and pass up into the epicotyl. The diagrams will help to explain this (Pl. 8. figs. 110, 111). 1–5 are the five root-poles, each of which divides into two. Cotyledon i. takes both halves of xylem 1, half of 2, and half of 5; the half of 5 becomes the downward branch into the cotyledon after a brief fusion with the midrib, which is composed of the rest of the vascular tissue. Cotyledon ii. similarly takes the whole of 4 and half of 3 as midrib, and half of 5 as downward branch. The remaining portions of 2 pass up into the plumule together with other new plumular bundles which appear at the cotyledonary node (not shown).

Van Tieghem (1870, p. 219) mentions that in the hypogeal *Dolichos lignosus* the root has a solid tetrarch xylem star, and that the cotyledons take two of the root protoxylems, the primordial leaves the other two.

Dodel (1872, p. 149) has published a very full account of the seedling structure of *Phaseolus vulgaris*, Linn. (Pl. 1. fig. 7), *P. multiflorus*, Linn., and *P. erectus*, Fisch. (var. *nanus*). These seedlings show great complexity of structure, and for this and other reasons they are difficult subjects of study. *P. compressus*, DC., was described by Gérard (1881, p. 346), but was found to exhibit no new anatomical features. The transition phenomena of some species described in the present paper show a close relationship to those elucidated by these earlier authors; while in others the occurrence of simpler and more complex types is put on record.

PART B.

SUMMARISED INFORMATION.

SUMMARY LIST.

INTRODUCTORY.

In the following tables an attempt is made to collect some of the information at present available on the form and structure of the seedlings of the Leguminosæ. The contents of the columns are as follows:—

I. The names of the genera and species whose seedlings have been examined, so far as is known to the present author. These are classified under their sub-orders, tribes, and sub-tribes, the system adopted being that of Taubert (1894). In several cases the genera alone are mentioned; these are mostly taken from the paper of Van Tieghem and Douliot (1888), who give a list of the number of protoxylem groups in the main roots of many genera, but do not mention the species examined. These may, of course, in some instances duplicate the information given for definite species; but it has been considered wise to include them, as they have a certain value when considering a group as a whole. (In some of these cases, where the genus contains but one species, the specific name and other information has been supplied from works of reference.) No rigid system of nomenclature has been adopted, but for the most part the names given are those retained in the 'Index Kewensis.'

II. The habit of growth of the mature plant is here indicated by a letter, as follows:—T = tree; S = shrub or woody perennial; P = herbaceous perennial; A = annual or biennial (hapaxanthic). (Arb = arboreal; H = herbaceous, when the exact habit is not known; in cases in which not even so much as this is known, the column is left blank.) An asterisk is affixed to the symbol when the plant is a climber.

III. In this column is indicated the type of germination, whether epigeal (E), hypogeal (H), or an intermediate condition in which the cotyledons hardly rise above ground (H–E).

IV. The length of the hypocotyl is here expressed in millimetres, the limits being the external collet and the base of the cotyledons or the cotyledon tube. These figures can have only an approximate significance, as the length of the hypocotyl varies much according to conditions; they express more accurately the relative than the absolute magnitude of different seedlings. The measurements are for the most part taken from an average of my own seedlings; these are recorded even when they show discrepancies from those given in certain species by Lubbock (1892).

In the hypogeal species this column is not usually filled.

V. Here is given the diameter of the hypocotyl. Where only one number is given it indicates that the hypocotyl is of uniform diameter throughout; where two numbers, separated by an arrow, are quoted, the first number refers to the diameter at the external collet, the second to that at the summit of the hypocotyl. In the case of hypogeal seedlings the diameter is taken immediately below the cotyledons. When a prominent collar is developed at the base of the hypocotyl (*Acacia*, &c.) the diameter is taken just above this.

VI. The dimensions of the cotyledon lamina. The first figure refers to its length, the second to its breadth, and when a third figure is given it refers to its thickness; the maximum dimension being taken in each case.

VII. In this column are given the facts as to the number of protoxylems in the root and the type of symmetry on which the transition is effected. When a single figure is shown here it indicates that the symmetry is constant throughout. When two or three figures are given, separated by arrows, changes in symmetry within the axis are to be understood; in each case the first number refers to a level below that of the second, and this again to a level below that of the third: the last number thus indicates the symmetry at the node. When two or more figures, separated by commas, are given, it is indicated that the number of protoxylems varies in different specimens.

VIII. Here an attempt is made to classify the various kinds of transition phenomena in the vascular system according to the position in the seedling at which they occur. It must be understood, of course, that, as there are innumerable gradations between the extreme types, such a classification must be often arbitrary and largely an expression of personal judgment. Three terms are used to express the "level of transition":—

"High."—The greater part of the hypocotyl has a structure almost indistinguishable from that of a root; the transitional changes do not begin until high up in the hypocotyl, and are incomplete at the cotyledonary node.

"Low."—The transition phenomena begin some distance below the external collet, and are completed in the collet region—in extreme cases before the hypocotyl is entered. By the "completion" of the transition is understood the production of collateral stem-like bundles, with more or less centrifugal xylem; the root protoxylems may or may not persist as separate entities in the hypocotyl.

"Intermediate."—The transition phenomena usually begin in the region of the collet, and proceed slowly all the way up the hypocotyl, reaching completion near its summit. This type is subject to great variation in detail, and some attempt has been made to obtain a finer classification by speaking also of "intermediate-low" and "intermediate-high" transitions.

IX. This column contains references to the authorities for the statements contained in previous columns. The following abbreviations are used :—

Dod. = Dodel (1869).
vT. = Van Tieghem (1871, p. 221).
G. = Goldsmith (1876).
Gér. = Gérard (1881).
vT. & D. = Van Tieghem and Douliot (1888, p. 173).
Dan. = Dangeard (1889).
T. & T. = Tansley and Thomas (1906).
Tour. = Tourneux (1910).
Ch. = Chauveaud (1911).
C. = The present author.

X. Where a species is mentioned or described in the text the number of the page is inserted in this column, which thus forms an index to the paper.

No authorities are mentioned for the statements in Column II. as to the growth-form of the species. For information under this head various Floras have been consulted, especially Hooker's 'Student's Flora of the British Islands,' Hooker's 'Flora of British India,' Boissier's 'Flora Orientalis,' Hooker's 'Flora of New Zealand,' Rouy's 'Flore de France,' Torrey and Gray's 'Flora of North America,' and the 'Flora Capensis.'

I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.
MIMOSOIDEÆ	...	...	...	...	...	...	...	...	5
INGEÆ	...	...	...	...	...	...	...	...	7
Pithecolobium Saman, Benth.	T	E	40-60	2·0	11×7	8→4	Low	C.	8
P. Unguis-cati, Benth.	S, T	H	...	1·0	12×12×4	4	...	C.	9
Albizzia moluccana, Miq.	T	E	18	0·8	8×4	4	Int.-Low	C.	7
ACACIEÆ	...	...	...	...	...	...	...	...	5
Acacia doratoxylon, A. Cunn.	S, T	E	10	0·7	6×3	4	Int.-Low	C.	5
A. lanigera, A. Cunn.	S	E	30–45	1·0→0·7	7×5	4	Int.-Low	C.	...
A. neriifolia, A. Cunn.	S, T	E	30	1·0→0·5	7×4	4	Int.-Low	C.	...
A. suaveolens, Willd.	S	E	25	0·8→0·6	6×3	4	Int.-Low	C.	...
Acacia sp.	Arb	...	...	...	...	4	...	vT. & D.	...
EU-MIMOSEÆ	...	...	...	...	...	...	...	...	6
Leucæna glauca, Benth.	T	E	25	1·7	12×7	4	Int.-Low	C.	7
Schrankia uncinata, Willd.	P	E	10	1·5→1·0	6×4	4	Int.-Low	C.	7
Mimosa pudica, Linn.	S	E	15	0·6	5×5	4	Int.	C.	6
ADENANTHEREÆ	...	...	...	...	...	...	...	...	9
Adenanthera pavonina, Linn.	T	E	40	3·0→2·0	12×10	4	Low	C.	9
CÆSALPINIOIDEÆ	...	...	...	...	...	...	...	...	10
AMHERSTIEÆ	...	...	...	...	...	...	...	...	10
Saraca cauliflora, Baker	T	E	35	2·8	15×10	4	Low	C.	11
Saraca sp.	Arb	...	...	...	...	2	...	vT. & D.	11
Trachylobium Hornemannianum, Hayne	T	E	35	3·5	18×14	4	Low	C.	11
Tamarindus indica, Linn.	T	E	70	3·0	20×15	4	Low	C.	10
Intsia africana, Thouars	T	E	65	5·0→3·0	25×13×10	4	Low	C.	11
BAUHINIEÆ	...	...	...	...	...	...	...	...	12
Cercis sp.	Arb	...	...	...	...	2	...	vT. & D.	14
Bauhinia acuminata, Linn.	S	E	15	2·5→1·5	18×10	4	Low	C.	13
B. grandiflora, Juss.	S	E	15	2·0	13×10	4	[Low]	C.	...
B. Hookeri, F. Muell.	T	H–E	20	2·5	20×12	4	Low	C.	12
B. purpurea, Linn.	T	H–E	10	3·0	18×13	4	Low	C.	13
B. racemosa, Lam.	S, T	H–E	15	2·2→2·0	18×12	4→6, 6	Low	C.	14
B. tomentosa, Linn.	S	E	25	1·1→0·9	13×8	4	Low	C.	14
B. variegata, Linn.	T	E	60–70	2·5→1·5	30×20	4	Low	C.	12
B. yunnanensis, Franch.	S*	H–E	5	2·0	13×10	2→4	Low	C.	13

CASSIEÆ	...	...	...	...	...	...	...	Dan. : C. vT. & D. T. & T.	15
Ceratonia Siliqua, Linn.	T	E	45	3·0→2·0	20×11	4	Low		15
Labichea lanceolata, Benth.	S	E	16	2·5→1·0	8×5	4	Int.-Low	C.	17
Petalostylis labicheoides, R. Br.	S	E	30	1·6→0·5	8×5	4	High	C.	18
Cassia brasiliana, Lam.	T	E	30	1·0	17×13	4	Int.-Low	C.	17
C. floribunda, Cav.	S	E	20	1·2→0·8	10×7	4	Int.-Low	C.	17
C. lævigata, Willd.	S	E	20	1·7→1·0	9×7	4	Int.-Low	C.	17
C. siamea, Lam.	T	E	25	1·5→1·0	11×8	4	Int.-Low	C.	17
C. sumatrana, Roxb.	T	E	20	1·0	17×12	4	Int.-Low	C.	17
Cassia sp.	...	...	...	...	...	4	...	vT. & D.	...
EU-CÆSALPINIEÆ	...	...	...	...	...	...	...	...	18
Gleditschia sp.	...	...	...	...	...	4	...	vT. & D.	...
Acrocarpus fraxinifolius, Wight & Arn.	T	E	35	1·5→1·0	10×7	4	Low	C.	19
Parkinsonia aculeata	S, T	E	40	1·1	12×7	4	Low	C.	18
Poinciana regia, Boj.	T	E	30	3·0	...	4	Low	C.	20
Cæsalpinia coriaria, Willd.	S	E	35	1·0	9×7	4	Low	C.	19
C. pulcherrima, Sw.	S, T	E	50	2·5→2·0	13×10	4	Low	C.	19
C. Sappan, Linn.	T	H	...	2·0	20×12	4	...	C.	20
C. sepiaria, Roxb.	Arb*	H	...	2·5	...	4	...	C.	21
Guilandina Bonducella, Linn.	S*	H	...	3·0	30×25×20	4	...	C.	21
PAPILIONATÆ	...	...	...	...	...	...	...	...	22
SOPHOREÆ	...	...	...	...	...	...	...	...	22
Castanospermum australe, A. Cunn.	T	H	...	8·0	50×45×25	6–8	...	C.	23
Sophora chrysophylla, Seem.	...	H	5	1·8	10×6	2	...	C.	23
S. tetraptera, J. Mill.	T	H	3	1·2→2·0	8×8	2	...	C.	23
Virgilia capensis, Lam.	T	...	...	...	...	4	...	vT. & D.	78
PODALYRIEÆ	...	...	...	...	...	...	...	...	23
Thermopsis montana, Nutt.	P	E	15	1·5	11×6	2	Int.	C.	25
Baptisia leucantha, Torr. & Gray	P	E	17	1·3	10×5	2	High	C.	24
Baptisia sp.	H	...	...	...	...	2	...	Dan.	...
Chorizema cordatum, Lindl.	S	E	12	0·7	7×2	4→2	High	C.	24
Viminaria denudata, Sm.	S	E	14	1·1	9×3	4	High	C.	23
Pultenæa daphnoides, Wendl.	S	E	25	0·8	8×3	4→2	High	C.	24
GENISTEÆ	...	...	...	...	...	...	...	...	25
CROTALARIINÆ.									
Crotalaria incana, Linn.	?	E	22	0·9→0·7	7×4	2	Int.	C.	27
C. retusa, Linn.	S	E	30–40	1·3	12×4	2	Int.-Low	C.	26
C. striata, DC.	S	E	40	1·0	8×3	2	Int.-Low	C.	27

I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.
PAPILIONATÆ (*cont.*).									
SPARTIINÆ.									
Lupinus hirsutus, Linn.	A	E	40	2·0→3·0×5·0	18×12	2	Low	C.	29
L. mutabilis, Sweet	S	E	70	3·0→2·0	15×10	2	Low	C.	28
L. varius, Linn.	A	...	...	...	...	2	...	vT.	...
Lupinus sp.	...	...	...	...	...	2	...	vT. & D.	...
Spartium junceum, Linn.	S	E	30–35	1·0	8×6	2	Int.	C.	25
Genista æthnensis, DC.	S	E	15	0·9→0·6	5×4	2	High	C.	26
G. hispanica, Linn.	S	E	20	1·0→0·6	8×5	2	Int.	C.	26
Genista sp.	S	...	...	...	...	2	...	vT. & D.	...
Laburnum vulgare, Presl	T	E	25	1·0→0·8	12×9	2	Int.-Low	C.	27
CYTISINÆ.									
Ulex europæus, Linn.	S	E	12	1·0	10×5	2	Int.-High	C.	28
Cytisus canariensis, Steud.	S	E	12	1·0→0·8	5×4	2	Int.-High	C.	28
C. hirsutus, Linn.	S	E	30	0·9→0·7	7×4	2	Int.-High	C.	28
C. purpureus, Scop.	S	E	30	1·2→1·0	10×6	2	Int.	C.	28
Cytisus sp.	Arb	...	...	...	...	2	...	vT. & D.	...
TRIFOLIEÆ	...	...	...	...	...	...	...	...	30
Ononis biflora, Desf.	A	E	30	1·0	10×6	2	Int.	C.	30
O. rotundifolia, Linn.	S	E	13	1·0	7×4	{ 4→2 3→4→2 }	High	C.	30
Ononis sp.	...	...	...	...	...	2	...	vT. & D.	...
Trigonella cretica, Boiss.	A	E	18	1·5→1·2	25×11	3→4	High	C.	33
T. Fœnum-græcum, Linn.	A	E	20	1·1	12×4	4	High	C.	32
T. gladiata, Stev.	P	E	30	1·3→1·0	13×6	4, 3→4	High	C. : Ch.	32
Trigonella sp.	H	...	...	...	...	2	...	vT.	...
Trigonella sp.	H	...	...	...	...	3	...	vT. & D.	...
Pocockia sp.	H	...	...	...	...	3	...	vT. & D.	...
Medicago falcata, Linn.	P	E	20	0·7	8×3	3→4	High	Gér. : C.	34
M. lupulina, Linn.	A	E	12	0·7	8×4	3→4	High	C.	33
M. sativa, Linn.	P	E	...	...	...	3, 4	...	vT.	35
M. tribuloides, Desr.	A	E	30	1·0→0·9	12×8	4	High	C.	31
M. turbinata, Willd.	A	E	15	0·6→0·5	5×3	3→4→2	High	C.	34
Medicago sp.	...	...	...	...	...	4	...	vT. & D.	...
Melilotus arvensis, Wallr.	A	E	20	0·6	10×6	3→2	High	C.	35

Melilotus speciosa, Dur.	A	E	...	0·6	...	[3]	High	C.	...
Melilotus sp.	A	...	...	...	...	4	...	vT. & D.	...
Trifolium arvense, Linn.	A	E	11	0·7	4×2	3→4	High	C.	34
T. hybridum, Linn.	P	E	10	0·4	4×2	3→4	High	C.	34
Trifolium sp.	H	...	...	...	...	4	...	vT. & D.	...
LOTEÆ	...	...	...	...	...	...	...	...	35
Anthyllis Barba-Jovis, Linn.	S	E	12	0·8→0·6	6×4	2	High	C.	35
A. tetraphylla, Linn.	A	E	18	1·5	18×10	4	Int.-High	C.	36
A. Vulneraria, Linn.	P	E	18	0·7→0·5	13×4	2	High	C.	36
A. Vulneraria var. *Dillenii*, Schult.	P	E	18	0·7→0·5	13×4	2	High	C.	36
Bonaveria Securidaca, Scop.	A	...	...	...	...	3	...	vT. & D.	...
Hosackia Purshiana, Benth.	A	E	...	0·8	...	[4]	High	C.	37
Hosackia sp.	...	...	...	...	...	3	...	vT. & D.	...
Dorycnium hirsutum, Sér.	S	E	20	0·9→0·7	7×5	{ 2→3→4, 3→4, 4 }	Int.-High	C.	38
Lotus corniculatus, Linn.	P	E	14	0·6	4×2	3	High	C. : Ch.	38
L. Requieni, Mauri	A	E	20	1·0	10×8	4	Int.-High	C.	37
L. Tetragonolobus, Linn.	A	E	40–50	1·9	11×9	4	Int.-High	C.	37
Lotus sp.	...	...	...	...	...	3	...	vT. & D.	...
GALEGEÆ	...	...	...	...	...	...	...	...	39
INDIGOFERINÆ.									
Indigofera galegoides, DC.	S	E	13	0·8	7×3	4	Int.	C.	39
I. sumatrana, Gaertn.	S	E	15–20	0·8	7×5	4	Int.	C.	39
I. tinctoria, Linn.	S	E	20	0·8	7×5	4	Int.	C.	39
I. sp. (? *pulchella*, Roxb.)	[S]	E	10	0·9→0·7	7×4	4	Int.	C.	40
I. sp.	...	...	...	...	...	4	...	vT. & D.	...
PSORALIINÆ.									
Psoralea sp.	...	...	...	...	...	4	...	vT. & D.	...
Amorpha sp.	S	...	...	...	...	2	...	vT. & D.	83
Dalea sp.	...	...	...	...	...	2	...	vT. & D.	83
TEPHROSIINÆ.									
Galega officinalis, Linn.	P	E	15	1·0→0·9	14×5	[4→2]	High	C.	41
G. orientalis, Lam.	P	E	10	0·8	35×5	4→2	High	C.	40
Tephrosia purpurea, Pers.	P	E	30	1·0	13×5	4	Int.	C.	40
ROBINIINÆ.									
Sesbania sp.	...	...	...	...	...	4	...	vT. & D.	...
Carmichaelia australis, R. Br.	S	E	15	0·9→0·7	8×4	3→4	High	C.	43

I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.
PAPILIONATÆ (*cont.*).									
COLUTEINÆ.									
Clianthus sp.	...	...	...	...	...	4	...	vT. & D.	...
Sutherlandia frutescens, R. Br.	S	...	...	...	...	4	...	vT. & D.	...
Swainsona Cadelli, F. Muell.	P	E	12	1·3→0·9	8×5	3	Int.-High	C.	44
Colutea arborescens, Linn.	S	E	13	1·5→1·2	12×6	4	Int.	C.	41
C. cruenta, Dryand.	S	E	20	1·5→1·2	10×8	4	Int.	C.	41
ASTRAGALINÆ.									
Caragana arborescens, Lam.	S	E	13	1·0—1·2	10×4	3→4 3½→4 4	Int.-Low	C.	41
C. tragacanthoides, Poir.	S, T	E	15	1·0	7×4	3→4	Int.-Low	C.	43
Astragalus chlorostachys, Lindl.	S	E	25	0·9	11×4	3→4	Int.-High	C.	43
A. danicus, Retz., var. *albus*	P	E	15	1·0	14×7	3	High	C.	44
A. sp.	...	...	...	...	...	3	...	vT. & D.	...
Oxytropis campestris, DC.	P	E	14	0·6	10×5	3	High	C.	44
O. lapponica, Gaud.	P	E	18	0·6	...	3	High	C.	45
Biserrula Pelecinus, Linn.	A	E	15	1·2→0·8	...	3	Int.-High	C. vT.&D.(VII.)	45
HEDYSAREÆ	...	...	...	...	...	...	...	...	45
CORONILLINÆ.									
Scorpiurus subvillosa, Linn.	A	E	...	...	...	4	High	Dan.	48
S. sulcata, Linn.	A	E	12	1·2	40×1·2	3→4	High	C.	47
S. vermiculata, Linn.	A	E	40	1·2	90–100×1·5	4	Int.	C.	46
Scorpiurus sp.	H	...	...	...	...	3	...	vT. & D.	...
Ornithopus compressus, Linn.	A	E	18	0·6	5×3	3→4	High	C.	48
Ornithopus sp.	H	...	...	...	...	3	...	vT. & D.	...
Arthrolobium sp.	H	...	...	...	...	3	...	vT. & D.	...
Coronilla montana, Scop.	P	E	22	0·7→0·5	11×5	3→4	High	C.	48
C. varia, Linn.	P	E	12	0·8	16×5	3	High	C.	51
Coronilla sp.	...	...	...	...	...	3	...	vT. & D.	...
Hippocrepis comosa, Linn.	P	E	12	0·8	15×2	3	High	C.	51
H. unisiliquosus, Linn.	A	E	15	0·5	...	3→4	High	C.	49
EU-HEDYSARINÆ.									
Hedysarum coronarium, Linn.	P	E	15	0·8→1·3	12×9	3→4	Int.	C.	50
Hedysarum sp.	...	...	...	...	...	3	...	vT. & D.	...
Onobrychis Caput-galli, Lam.	P	E	25	2·2→1·8	18×9	3→4	Int.	C.	48
O. sativa, Lam.	P	E	18	1·9→1·3	12×7	3	Int.	C.: vT.	50
Onobrychis sp.	...	...	...	...	...	3	...	vT. & D.	...

PATAGONIINÆ.									
Adesmia sp.	...	...	...	...	...	2	...	vT. & D.	84
STYLOSANTHINÆ.									
Arachis hypogæa, Linn.	A	H–E	20	7·0→6·0×4·0	18×9	4	Low	C.	45
DESMODIINÆ.									
Desmodium canadense, DC.	P	E	20	0·8	7×5	4	Int.	C.	46
D. gangeticum, DC.	S	E	10	0·7→0·6	4×3	4	High	C.	46
Desmodium sp.	...	...	...	...	...	4	...	vT. & D.	...
Uraria picta, Desv.	P	E	...	...	...	4	Int.-High	C.	...
Lespedeza sp.	...	...	...	...	...	4	...	vT. & D.	...
DALBERGIEÆ	...	...	...	...	...	...	...	...	51
PTEROCARPINÆ.									
Dalbergia Sissoo, Roxb.	T	E	35	1·8→1·2	13×7	4	Low	C.	51
LONCHOCARPINÆ.									
Derris scandens, Benth.	Arb*	E	30	1·8	12×6	4	Low	C.	52
VICIEÆ	...	...	...	...	...	...	...	...	52
Cicer arietinum, Linn.	A	H	...	...	...	4	...	vT.	93
Vicia amphicarpæa, Dorthes	A*	H	...	1·0	...	3	...	C.	58
V. Ervilia, Willd.	A	H	...	...	...	3	...	vT.	...
V. Faba, Linn.	A	H	...	4·0	...	4, 5, 6, 7	...	C. : vT. & D.	55
V. sativa, Linn.	A*	H	...	1·0	...	3	...	G. : Tour. : C.	52
Vicia sp.	H	H	...	...	...	3	...	vT. & D.	...
Ervum Lens, Linn.	A*	H	...	1·1	..	3	...	Gér. : vT. : C. : Ch.	52
E. tetraspermum, Linn.	A*	H	...	...	...	3	...	vT.	...
Ervum sp.	H	H	...	...	...	3	...	vT. & D.	...
Lathyrus angustifolius, Martr.	P*	H	...	1·0	3×3	3	...	C.	58
L. latifolius, Linn.	P*	H	...	...	...	3	...	Gér.	52
L. Nissolia, Linn.	A*	H	...	0·4	2×2	3	...	C.	58
L. odoratus, Linn.	A*	H	...	...	...	3	...	Gér. : Ch.	52
L. sativus, Linn.	A*	H	...	2·0	10×10	3	...	vT. : C.	58
Lathyrus spp.	H	H	...	...	...	3	...	vT.&D. : Tour.	...
Orobus cyaneus, Stev.	P	H	...	0·7	...	3	...	C.	58
O. niger, Linn.	P	H	...	0·8	...	3	...	C.	58
O. vernus, Linn.	P	H	...	...	...	3	...	vT.	...
Orobus sp.	P	H	...	...	..	3	...	vT. & D.	...
Pisum Jomardi, Schrank	A*	H	...	3·5	...	3	...	C.	58
P. sativum, Linn.	A*	H	...	3·5	...	3	...	C. : vT. : Tour.	53
Pisum sp.	H	H	...	...	...	3	...	vT. & D.	...
Abrus precatorius, Linn.	S*	E	35	2·0→1·2	8×3	4	Low	Dan. : C.	57

I.	II.	II.	IV.	V.	VI.	VII.	VIII.	IX.	X.
PAPILIONATÆ *(cont.).*									
PHASEOLEÆ	...	...	...	...	...	...	...	...	58
GLYCININÆ.									
Clitorea Ternatea, Linn.	S*	E	45	1·5	21×14	4	Int.-Low	C.	59
Glycine hispida, Maxim.	H	E	35	2·3→1·8	17×9	4	Low	C.	60
Soja hispida, Moench	H	E	50	2·0→1·5	16×9	4	Int.-Low	C.	60
Soja sp.	H	...		...	...	4		vT. & D.	...
Kennedya retusa, F. Muell.	S*	E	18	3·0→1·1	13×4	4	Int.	C.	59
K. rubicunda, Vent.	P	E	20	1·7→0·8	11×4	4	Int.	C.	58
ERYTHRININÆ.									
Erythrina arborescens, Roxb.	T	H	...	6·0	20×12	[6→7]	...	C.	63
E. indica, Lam.	T	E	35	5·0	25×9	[7]	Low	C.	63
DIOCLEINÆ.									
Canavalia ensiformis, DC.	P*	E	110	4·0	27×17	4	Low	C.	62
C. gladiata, DC.	P*	E	110	4·0	27×17	4	Low	C.	62
CAJANINÆ.									
Cajanus indicus, Spreng.	S	H	...	2·0	9×6	4	...	C.	...
PHASEOLINÆ.									
Phaseolus compressus, DC.	A*	E	...	...	...	4	Low	Gér.	65
P. erectus Fisch., var. *nanus*	A	E	...	...	...	4	Low	Dod.	65
P. Hernandesii, Savi	A*	E	...	5·0	...	4	Low	C.	61
P. radiatus, Linn.	A	E	35	2·0→1·5	7×4	4	Int.-Low	C.	61
P. multiflorus, Linn.	A	H	...	...	...	4	Low	Dod.	65
P. vulgaris, Linn.	A*	E	...	4·0	...	4	Low	Dod.	65
Phaseolus sp.	H	...	...	...	...	4	...	vT. & D.	...
Voandzeia subterranea, Thouars	A	H	...	6·0	15×10×8	5, 7→9	...	C.	63
Pachyrrhizus angulatus, Rich.	S	H	...	2·0	10×8	4	...	C.	60
Dolichos lignosus Linn. (? Jacq.)	P	H	...	...	...	4	...	vT.	64
Dolichos sp.	...	...	...	...	...	4	...	vT. & D.	...

SUMMARIES OF THE DIFFERENT GROUPS.

MIMOSOIDEÆ.

The number of species of this sub-order which have been examined up to the present is comparatively small. Examples from four tribes have been investigated, but the sub-order may well be treated as a whole in the present condition of our knowledge.

The prevailing habit is arboreal, *Schrankia uncinata* being the only herbaceous perennial species yet examined.

In most cases the embryo is straight, and is often surrounded with endosperm. Germination is usually epigeal, but *Pithecolobium Unguis-cati* has large fleshy subterranean cotyledons. The seedlings vary much in size and in the thickness of the cotyledons. In the Acacieæ and Eu-Mimoseæ the cotyledons are rather thin and the seedlings are small; the hypocotyl is distended at the base into a prominent ring or collar composed entirely of cortical parenchyma. In the Ingeæ and Adenanthereæ larger seedlings occur with fleshy cotyledons and often no hypocotyl-collar.

The tetrarch type of symmetry occurs throughout the sub-order; but in *Pithecolobium Saman* the root is octarch changing to tetrarch below the collet.

The level of transition varies from "intermediate" in the smallest seedling studied to "low" in the two largest. The other species exhibit transitions in which a tangential position of xylem is attained at the collet region, this persisting through a great part of the hypocotyl and resulting in collateral bundles with exarch xylem at the cotyledonary node: this type being described as "intermediate-low."

The Acacieæ are characterised by the division of the original "ectophloic siphonostele" at the protoxylem, four tangentially differentiated bands of primary xylem being the result.

The Eu-Mimoseæ have the two inner xylems of each cotyledon trace somewhat smaller than the two outer: four bundles are only just recognisable in some cases, and the phloem is in two groups supplying each cotyledon.

The Ingeæ and Adenanthereæ agree in the occurrence of large seedlings with a wide pith in the root surrounded by wedge-shaped distinct primary xylems: the transition being low. *Albizzia moluccana* (Ingeæ), however, has a smaller seedling, whose "intermediate-low" transition shows features in common with Acacieæ and Eu-Mimoseæ.

The primary xylem of the root is usually cotyledonary: but in *Pithecolobium Unguis-cati*, an hypogeal species, the plumular traces connect directly with the proto- and metaxylem of the lateral root-poles.

A histological feature of the hypocotyl found also in many Cæsalpinioideæ, is the presence of a zone of small-celled and sometimes thick-walled tissue in the outer part of the cortex. Fibres are very generally present in the hypocotyl between the phloem and the endodermis.

CÆSALPINIOIDEÆ.

This sub-order comprises a majority of species of arboreal habit, and all whose seedlings have been examined up to the present time are shrubs, trees, or lianes.

The embryo is almost invariably straight, and is frequently enclosed in a large amount of endosperm, characters which ally the sub-order with the Mimosoideæ in contrast to the majority of the Papilionatæ. Germination is usually epigeal, but certain of the Bauhinieæ show a tendency to become hypogeal, and in the Eu-Cæsalpinieæ it appears that hypogeal germination is frequent. In some epigeal seedlings a prominent collar is found at the base of the hypocotyl, just as in many Mimosoideæ (e. g. *Parkinsonia aculeata*, *Petalostylis labicheoides*).

The seedlings vary greatly in size and form and in the relative development of parts. Some of them are small with slender hypocotyls and thin cotyledons (*e. g.* some Cassieæ); others have very stout hypocotyls with epigeal cotyledons of moderate size (e. g. *Intsia africana*); while others have relatively exaggerated cotyledons, and hypocotyls of comparatively restricted dimensions (e. g. *Guilandina Bonducella*): in certain cases the diameter of the hypocotyl diminishes very conspicuously from below upwards (e. g. *Labichea lanceolata*, *Petalostylis labicheoides*); in most seedlings some such tapering occurs, but not to the marked degree observed in these species.

It may be noticed that this sub-order shows certain parallels with the Mimosoideæ in the characters of their seedlings. The Cassieæ, for instance, may be compared with the Acacieæ and Eu-Mimoseæ both in external form and in structure. The Eu-Cæsalpinieæ show similarities to the Ingeæ, especially in the occurrence of both epi- and hypogeal forms; while the Amherstieæ may be put side by side with the Adenanthereæ.

The type of symmetry is remarkably uniform, tetrarchy being the general rule. Diarchy has, however, been recorded by Van Tieghem and Douliot (1888, p. 173) as occurring in *Saraca* and in *Cercis*; and *Bauhinia yunnanensis* shows diarchy in the root gradually changing to tetrarchy higher up the axis. *Bauhinia racemosa* exhibits some variety; some seedlings exhibiting tetrarch, others hexarch roots; the relation of these different types to one another is quite clear (p. 15).

The level of transition varies from "high" in *Petalostylis labicheoides*, the slenderest seedling studied, to what is perhaps the most pronounced type of low transition in the massive seedlings of *Intsia africana*, *Tamarindus indica*, &c. In these last the hypocotyl—even the upper part of the root—shows a stem-structure without any clear signs of root-like anatomy. The majority of seedlings, however, while exhibiting transitions best classified as low, do not attain the same degree of "lowness" as these large members of the Amherstieæ. The Cassieæ (excepting *Ceratonia Siliqua*) show a very uniform type of structure, the transition being best described as "intermediate-low." The level of the transition, so far as different species can be compared in this respect, thus follows roughly the diameter of the seedling; the large seedlings having low, the small seedlings high, transitions, and those of intermediate size ranging between these extremes. Special mention should be made of *Petalostylis labicheoides* and *Labichea lanceolata*; here the distension of the base of the hypocotyl has no distinct influence upon the level of transition, which is of the type appropriate to much slenderer seedlings. The stele in these cases remains narrow relatively to the breadth of the whole section, and the structure conforms with what would be expected if the whole hypocotyl had approximately the diameter of the upper part.

The primary xylem of the root in most cases is exclusively cotyledonary. In *Bauhinia racemosa*, however, the intercotyledonary plumular bundles may play a part in the construction of the root. *Cæsalpinia sepiaria* is peculiar in that two of the root protoxylems are plumular and two cotyledonary; the former show a persistence of mesarchy and a double structure for some distance up the first epicotyledonary internode.

PAPILIONATÆ.

In this, the largest sub-order of the Leguminosæ, we find an immense amount of variety in every detail of form and structure. The mature plant may be a tree, shrub, liane, switch-plant, annual or perennial herb of erect, prostrate, or climbing habit. The seed varies widely in size, but is almost always devoid of endosperm. The embryo is usually curved, the radicle being accumbent; but in *Cicer*, *Arachis*, *Voandzeia*, and some Dalbergieæ and Sophoreæ the radicle is very short and straight (Taubert, 1894, p. 185). In certain Hedysareæ the cotyledons are long and twisted in the seed, but in most cases they are simply folded face to face. The pressure of the hilum and radicle on the same edge makes them often more or less asymmetrical.

Germination in some tribes is usually epigeal, a tendency to become hypogeal being occasionally shown; but the Vicieæ and Sophoreæ are almost entirely hypogeal, and this mode of germination is also frequent in the Phaseoleæ and Dalbergieæ. The size of the seedling varies within wide limits, the volume of the hypocotyl of *Canavalia ensiformis*, for instance, being about seventy times that of *Hippocrepis unisiliquosus*.

The seedling anatomy naturally reflects this manifold variety, though a certain uniformity is discernible throughout the sub-order. It will be convenient to summarise the information acquired for the different tribes of Papilionatæ separately; for it often happens that a definite type of structure proves to be characteristic of a taxonomic group of species.

SOPHOREÆ.

This tribe, regarded as one of the most primitive of the Leguminosæ and as affording a transition between the Papilionatæ and the Cæsalpinioideæ, has been imperfectly studied so far in respect of seedling anatomy.

The three species examined have hypogeal germination *, but while in *Castanospermum australe* the collet abuts on the cotyledonary node, in the species of *Sophora* a few millimetres of hypocotyl intervene. *Castanospermum australe* has the largest seed and seedling of any of the Leguminosæ so far examined; but those of *Sophora* spp. are comparatively small, as in many Vicieæ. The cotyledons are inserted opposite one another.

The type of symmetry varies widely; diarchy occurs in *Sophora* spp., tetrarchy in *Virgilia capensis* according to Van Tieghem and Douliot (1888, p. 174), while the complex *Castanospermum australe* may be hexarch or octarch. All the protoxylems of the root are cotyledonary in the cases studied; but in *Sophora* spp. a very definite direct connection occurs between plumular xylem and the metaxylem of the hypocotyledonary axis; a similar connection was observed in one case in *Castanospermum*.

PODALYRIEÆ.

This tribe, with the Sophoreæ considered as the most primitive of the Leguminosæ, exhibits certain important features in seedling structure, though this has not been adequately studied.

Germination in all the cases on record is epigeal; the seedlings are comparatively small, the hypocotyl uniform in diameter throughout, the cotyledons oblong or ovate, slightly thickened.

The mature plants are small or medium-sized shrubs, or herbaceous perennials; in the examples studied the seedlings of the former show a tetrarch, of the latter a diarch root. *Viminaria denudata* exhibits an ordinary type of transition, in which the polar xylems are converted into double bundles and are joined by the halves of the lateral xylems; all four root-poles being cotyledonary. In *Pultenæa daphnoides* and *Chorizema cordatum* the transition begins in the same way from a tetrarch root, but the lateral xylems never enter the cotyledon, dwindling away in the upper part of the hypocotyl; the cotyledon trace being simply a double bundle derived from a polar root xylem. Physiologically the lateral root-poles have a relation, not with the cotyledons as in *Viminaria denudata*, but with the first two plumular traces. In *Baptisia leucantha* and *Thermopsis montana* no lateral root-poles are developed, the transition being on the diarch plan throughout; this, as well as certain histological features, suggesting a connection with the neighbouring tribe Genisteæ. It may be noticed that the two largest seedlings with the broadest cotyledons are diarch, the three smallest showing tetrarchy (contrast p. 117, &c.). There can be little doubt that the three types constitute a phylogenetic series.

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* Lubbock (1892, p. 452) also describes as hypogeal *Sophora secundiflora*, *Edwardsia chilensis* (= *Sophora macrocarpa*), and *Myroxylon peruiferum*. (The epigeal *Hæmatoxylon campechianum* is included in the Sophoreæ by error.) According to De Candolle (1825, pl. 4), however, *Sophora japonica* and *Virgilia aurea* (= *Calpurnea lasiogyne*) are epigeal.

The level of transition shows a definite relation to the diameter of the hypocotyl. A series arranged in order of decreasing diameter is also arranged in order of increasing height above the collet at which pith begins to appear. The largest seedling, *Thermopsis montana*, may be said to have an intermediate transition; while in the other species the transition is high.

GENISTEÆ.

The Genisteæ include species with a considerable variety of habit; some are trees, others large or small shrubs, sometimes leafless or spiny, others thick-stemmed annuals. The prevailing habit is woody, and the seedlings are sometimes unusually rigid.

The seedlings are epigeal. The hypocotyl sometimes extends high above the ground, sometimes is short so that the cotyledons are unfolded near the surface. The cotyledons are more or less fleshy, in some cases becoming leaf-like, in others functioning chiefly as storage organs. In most cases, owing to the accumbent position of the radicle in the seed and to the pressure of the hilum, the cotyledons are somewhat asymmetrical and sometimes have a sinus on one side; the venation is pinnate. There is a great variation in size of seedling within the tribe, the variation not being correlated with the bulk of the mature plant, though perhaps somewhat related to the rate of growth. *Laburnum vulgare*, a tree, has a hypocotyl of about $\frac{1}{27}$ the volume of that of *Lupinus mutabilis*, a low shrub, and about $\frac{1}{8}$ of that of *Lupinus hirsutus*, an annual herb. On the whole, however, the seedlings are fairly small, 1·0 mm. being a usual diameter.

So far as is known, the root is uniformly diarch throughout the tribe, despite the variation in size and mature habit; the xylem plates are never uniseriate, so far as known, usually consisting of two rows of stout-walled vessels of rather characteristic appearance. In some cases the two xylem plates may become continuous through the centre of the stele at the end of the first phase of development (e. g. *Cytisus* spp.); in others they remain distinct (e. g. *Spartium junceum, Lupinus mutabilis*). In many cases the xylems are more than biseriate and may be wedge-shaped. The primary phloems often, but not always, contain fibres.

The cotyledon trace almost invariably consists of a pair of more or less widely separated collateral bundles with endarch xylem, and a small intervening protoxylem group which comes directly from a root-pole; this last may rarely acquire a tiny phloem bundle immediately outside it, thus forming a median collateral bundle (e. g. *Lupinus mutabilis*). In a few cases, however, the transition is incomplete below the node (e. g. *Genista æthnensis*).

The level of the transition varies from low in the stoutest seedlings (*Lupinus* spp.) to high in the slenderest (*Genista æthnensis*). The seedlings of intermediate diameter have rather diverse levels of transition relatively to collet and cotyledons. A more strict accordance is produced if we take into account the length of the hypocotyl as well as its diameter; it is found that the order of transition level from low to high is also the order of bulk of the hypocotyl, from great to small. This seems to imply that the apparent level of transition depends partly on the absolute distance between collet and cotyledons. Given two seedlings of equal diameter: if the *velocity* of transition be the same in both, the *level* will appear to be lower in the one with the longer hypocotyl; we may thus compare *Crotalaria striata* with *Cytisus canariensis*. It is possible that in some cases the absence of fibres may necessitate greater mechanical strength on the part of the aerial hypocotyl, and may thus produce a lower transition than would be the case if fibres were present (compare *Laburnum vulgare* with *Spartium junceum*, for instance). The height to which the cotyledons are borne above ground may also have an influence (e. g. *Ulex europæus*).

Owing to the uniformity of structure the Genisteæ are a favourable tribe for the study of the factors which influence the level of transition. It appears that this uniformity must be due to a hereditary factor, and that therefore seedling characters may to some extent be useful as indications of relationships. This view is strengthened by the fact that in *Ononis*, one of the Trifolieæ, but nearly related to the Genisteæ, a Genisteæ-type of structure may occur.

TRIFOLIEÆ.

The great majority of the Trifolieæ are of herbaceous habit, whether annual or with a perennating root-stock: rarely the habit is shrubby (*Ononis rotundifolia*). Many of the species are weak-stemmed and procumbent.

The seedlings are all epigeal, so far as is known, and in most cases the cotyledons are borne high above the ground. The hypocotyl is slender and rather weak. The cotyledons are leaf-like, more or less ovate, often shortly petioled; in the genera *Trifolium*, *Melilotus*, *Trigonella*, &c. there is a joint between the lamina and the petiole similar to that seen in the foliage-leaves: its presence may be an example of correlative variation between cotyledons and leaves if taken as indicating a derivation of the latter from a higher degree of pinnation (cf. *Berberis*, *Citrus*); or it may be regarded simply in the light of its function as a hinge for nyctitropic movements. This joint is absent from the cotyledons of *Medicago* spp.

(*cf.* Urban, 1873, p. 33). In *Ononis biflora*, and also in other species of this genus (De Candolle, 1825, p. 86), the cotyledons exhibit the very rare condition of pronounced hairiness. There is often a short one- or two-sided cotyledonary tube.

There is some variation in the symmetry of the vascular structure within the tribe, and also within single genera and species; moreover, individual seedlings show differences in symmetry at different levels. In the majority of cases a tetrarch structure occurs in some part of the hypocotyledonary axis, the only exception definitely known being *Ononis biflora*, a plant which exhibits in its seedling structure a relationship to the Genisteæ also evinced by floral and vegetative characters. The other species of this genus examined, *O. rotundifolia*, while showing some kinship with the Genisteæ, is more conspicuously related to the other Trifolieæ.

In some cases the root is tetrarch throughout, e. g., *Medicago tribuloides*, *Trigonella Fœnum-græcum*, and some seedlings of *T. gladiata*; but it is more usually triarch. In the majority of cases this triarchy is transformed to tetrarchy at a higher level (usually in the collet region) by the division of a phloem and the appearance of a new protoxylem between the two halves; the new xylem being in the intercotyledonary plane. The cotyledon traces may be derived from the tetrarch structure in one of two ways: the intercotyledonary xylem may divide in half along the minor axis of the stele, and each cotyledon will then receive a polar xylem and two half-lateral xylems; this happening in most cases: or the intercotyledonary protoxylems may disappear completely, leaving the polar groups from which alone are the cotyledon traces organised; this being observed in *Ononis rotundifolia* and *Medicago turbinata*. In these latter cases the root is sometimes triarch; and consequently we find the curious phenomenon of a protoxylem confined entirely to a more or less limited range of the hypocotyl (in *O. rotundifolia*, for instance, sometimes only about 3 mm. long), and prolonged neither into the root nor into the hypocotyl. In a single species, viz. *Melilotus arvensis*, the structure is similar but for the complete absence of the fourth protoxylem, triarchy passing directly to diarchy.

The cotyledon traces are of a similar type throughout the tribe, consisting of a small crushed median protoxylem row flanked by a pair of oblique or collateral bundles; the tetrarchy of the upper part of the hypocotyl of many species is not connected with the formation of lateral bundles at the base of the cotyledon, but is only revealed by the presence of small crushed vessels towards the edge of the collateral bundles.

The level of the transition is high throughout, with the exception of *Ononis biflora*, where it is intermediate. The diameter of the hypocotyl is such as appears to be normally correlated with a high transition, except in *Trigonella cretica*, where it is unusually stout. It may be that the root-structure of the greater part of the hypocotyl is a character which, ensuring flexibility, is of value in relation to the prostrate habit of so many species; but this will not account for *T. cretica,* which has an erect habit of growth. (Compare *Lotus Tetragonolobus.*) It is possible that here the highness of transition is a hereditary tribal character, and this may be the case also in the Loteæ.

LOTEÆ.

This tribe includes annual and perennial herbs and a few small shrubs.

The seedlings, so far as recorded, are all epigeal, the cotyledons being borne some distance above the ground. The hypocotyl is often slender, but in *Lotus Tetragonolobus* it attains 1·9 mm. in diameter and sometimes reaches 50 mm. in length. The cotyledons are foliaceous and not usually fleshy; there is often a pronounced joint between petiole and lamina which serves, e.g. in *L. Tetragonolobus*, for nyctitropic movements. (*Cf.* Trifolieæ.)

The type of symmetry varies much, as in the Trifolieæ. Some species are persistently diarch, others triarch, and others tetrarch. In *Dorycnium hirsutum* we find all three conditions occurring in the root; in the case of triarch seedlings a tetrarch symmetry is assumed in the upper part of the hypocotyl; in the case of diarchy the same thing also occurs, a triarch stage being passed through; in all cases the structure of the upper part of the hypocotyl is founded on a tetrarch plan. Within the same genus the type of symmetry may vary; as in *Anthyllis,* where the structure may be diarch or tetrarch, and *Lotus,* where it may be triarch or tetrarch. In cases of diarchy each cotyledon takes one of the two polar protoxylems; in tetrarchy each takes the same with the addition of two halves of the intercotyledonary protoxylems; in the one case of persistent triarchy (*Lotus corniculatus*), the third xylem becomes almost extinct below the cotyledons, but is shared between them.

The cotyledon traces are on the whole similar throughout the tribe, and resemble those of the Trifolieæ. Whatever the symmetry the cotyledon trace consists of a median polar protoxylem and a pair of collateral bundles; in seedlings with a tetrarch phase the half-lateral protoxylems are seen attached to the edge of these collateral bundles.

The transition appears to be persistently high or intermediate-high; in all cases root-like structure obtains in the lower half of the hypocotyl, and often for a considerable distance higher. The highness of the transition is remarkable in *Lotus Tetragonolobus*, which is a large seedling, whose size would lead one to expect a much lower transition. (Cf. *Trigonella cretica,* among the Trifolieæ.)

GALEGEÆ.

The majority of the species of this tribe are perennial herbs or shrubs; a few are small trees or annual herbs.

Germination is epigeal, with (according to Lubbock, 1892, p. 390) some tendency to become hypogeal. The hypocotyl is usually slender, often slightly hairy. The cotyledons are frequently more or less deeply notched on one side owing to the pressure of the hilum and the accumbent radicle. A short cotyledonary tube is generally present.

The vascular symmetry varies within the tribe, diarchy, triarchy, and tetrarchy occurring. It is noticeable that these types appear to be associated with systematic position. The Astragalinæ uniformly exhibit triarchy, at least in some individuals; the *Indigofera* spp. and the Psoraliinæ display tetrarch and diarch roots. It appears probable that the proximate cause of this relation is the fact that in the Indigoferinæ and Psoraliinæ the first two leaves are usually opposite (alternate in *Dalea annua*, according to De Candolle), while in the Astragalinæ they are alternate (see below, p. 103).

The tetrarch structure in the majority of cases persists through the whole seedling. In *Galega* spp., however, it is reduced to diarch by the disappearance of the intercotyledonary protoxylems in the upper part of the hypocotyl. In many cases of triarchy each cotyledon receives one and a half root xylems; but in several species a fourth protoxylem appears high in the hypocotyl; this fourth xylem may be shared equally between the two cotyledons, or (in one instance, *Carmichaelia australis*) may pass entirely to one cotyledon. In one seedling of *C. australis* the third protoxylem entered wholly into one cotyledon, the fourth into the other. The cases of diarchy in the root (*Dalea* and *Amorpha*) rest upon the assertion of Van Tieghem and Douliot, and no similar example was investigated.

In *Caragana arborescens* the symmetry varies in different seedlings, being either triarch, tetrarch, or an intermediate condition. This may be connected with the variability in position of radicle and cotyledons, or with the varying diameter of the hypocotyl.

Thus the variations of symmetry in the Galegeæ show many parallels to those already described in the Trifolieæ and Loteæ, and to be mentioned in the Hedysareæ.

The cotyledon traces contain a median polar protoxylem and a pair of metaxylems; lateral vascular bundles are not present, even in tetrarch seedlings, the phloem always remaining entire or only showing very faint signs of dividing.

The level of the transition varies from high to intermediate-low. Though, on the whole, the highest transitions are found in the slenderest seedlings, yet in the case of the middle transitions there is no strict parallelism between size and level of transition; this may be largely the result of imperfect classification of types, a task of considerable difficulty and uncertainty.

HEDYSAREÆ.

The majority of species of Hedysareæ are herbaceous annuals or perennials; a few are shrubby. In many cases more than one stem is produced by the plumule.

The germination is almost always epigeal; De Candolle (1825) among 37 species recorded no exception to this rule; but *Arachis hypogæa* is apparently very near to being hypogeal, for though the cotyledons usually appear above ground, they are very thick and fleshy, do not expand, and never turn green; Lubbock (1892, p. 392) mentions that "the cotyledons of *Lespedeza juncea* are subterranean, or if they rise above ground they perish early." According to Lubbock, the cotyledons of *Lespedeza* are densely pubescent (cf. *Ononis biflora*). There is much variety in the form of the cotyledons, the two main types being the ovate and the linear; the latter is found in *Scorpiurus* and *Hippocrepis*, the former in most other genera. The cotyledons of *Scorpiurus vermiculatus* may reach 10 cm. in length, but remain uniformly narrow and contain throughout a median and two lateral bundles. A cotyledonary tube is frequently present, being especially well-marked in *Hedysarum coronarium*; it is often closed for a greater distance on one side than on the other. Where the first leaves are alternate the cotyledons are more or less secund, being turned away from the side on which the first leaf appears; the cotyledons have often a straighter edge on this side than on the other, owing to the incumbent folding of the radicle against this edge in the seed and to the pressure of the hilum. *Arachis hypogæa* is one of the few Papilionatæ with a straight embryo.

The root may exhibit tetrarchy or triarchy, both conditions being common, and sometimes found within the limits of a genus. Diarchy is recorded for the single example of the sub-tribe Patagoniinæ examined, viz. *Adesmia* (Van Tieghem and Douliot, 1888, p. 173); but has not been observed elsewhere. Triarchy seems to be characteristic of the sub-tribes Coronillinæ and Eu-Hedysarinæ, in which the first leaves are alternate, or else more than one stem is produced from the plumule; but triarchy has not been found in the Desmodiinæ, in which the first two leaves are frequently opposite, tetrarchy being the general rule. Tetrarchy is also found in the roots of some Coronillinæ. This relation between the type of symmetry and the position of the first two leaves has been observed also in the Galegeæ, and appears to be a general principle (pp. 83, 103).

When tetrarchy occurs in the root it persists throughout the hypocotyl, and each cotyledon takes a polar xylem and halves of the two lateral xylems, together with two of the phloems from the root. In some cases of triarchy each cotyledon takes one and a half root xylems, and one and a half root phloems.

Between uniform tetrarchy and triarchy there is an interesting series of seedlings in which a fourth protoxylem is added to the triarch structure of the root. In *Onobrychis Caput-galli* the fourth xylem appears at the external collet. In *Scorpiurus sulcata* the same may happen, or in some cases tetrarchy is not attained till half-way up the hypocotyl. In *Ornithopus compressus* the fourth xylem appears in the upper part of the hypocotyl just below the level of the division of the third xylem. In *Hippocrepis unisiliquosus* and *Coronilla montana* the fourth xylem never appears as such, but is represented by its two halves, which arise above the level of forking of the third xylem. Finally, in *Hedysarum coronarium* the whole of the hypocotyl is triarch, but the fourth xylem arises *de novo* in the cotyledonary tube. Thus we have a complete series of stages connecting triarchy and tetrarchy; in which direction the series is to be read will be discussed later (p. 105).

In no case is there a reduction in the number of xylem poles as the hypocotyl is ascended. (Contrast certain Podalyrieæ, Galegeæ, and Trifolieæ.)

The cotyledon trace usually consists of a median polar protoxylem and a pair of collateral bundles, the latter having one or two lateral half-protoxylems attached; it usually gives off branches immediately on entering the cotyledon, even where this is very narrow. In *Arachis hypogæa* also the cotyledon trace is essentially of the same type, despite the unusual form of the seedling.

The level of the transition varies widely, being low in *Arachis hypogæa*, the largest seedling studied; intermediate in seedlings with diameters over 1·0 mm. (except *Scorpiurus sulcata*) and also *Desmodium canadense*, and high in the slenderest seedlings. A certain parallelism can thus be recognised between the diameter and the level of transition. The exceptional case of the two *Scorpiurus* spp., *S. sulcata* with a high, and *S. vermiculatus* with an intermediate, transition, both having the same diameter, may probably be explained by the much greater length of the hypocotyl in the latter species (*cf.* Genisteæ, p. 80).

DALBERGIEÆ.

The tribe contains exclusively arboreal species, some being trees, others lianes, often showing anomalous secondary thickening in the stem.

The germination is imperfectly known. De Candolle (1825) observed a single species, Lubbock (1892) three, and two others are recorded here. In each case the seedling is large and the cotyledons are epigeal; they are sometimes foliaceous; sometimes fleshy, not green and not expanding (*cf.* Phaseoleæ). The first two leaves are opposite, this being also comparable with the Phaseoleæ.

The root is tetrarch in the two species examined, all the four protoxylems being cotyledonary; the transition in both is low. In details of structure, however, the two species show certain marked differences.

VICIEÆ.

The great majority of species of this tribe are herbaceous climbers, annuals or perennials: most climb by means of tendrils; *Lathyrus Nissolia* supports itself by the tips of its phyllodes; *Abrus precatorius* is a twining plant; *Vicia Faba* does not climb. *Abrus* and *Cicer* tend to be woody.

The great majority of the seedlings of this tribe show an extraordinarily uniform type of structure. Germination is hypogeal; the cotyledons being large and fleshy, and but rarely becoming green even when exposed to light. The hypocotyl is very short, and in many cases the root-like surface extends up the axis to the very base of the cotyledons. Below the cotyledons the axis tapers continuously to a long primary root. The cotyledons are inserted on the axis at an angle of about 120° from one another, the re-entrant angle being bisected by the plane in which lies the first epicotyledonary bract. The anomalous genus *Abrus* shows a germination more nearly resembling that of certain Phaseoleæ; it is epigeal, the cotyledons are opposite, and the first pair of leaves are opposite also. In most cases the root contains three similar primary xylem groups, of which one supplies each cotyledon and the third passes above the cotyledonary node and enters the first bract-like leaf. In *Vicia Faba*, the largest seedling of this tribe studied, the structure is more complex: two of the root bundles enter the epicotyl, and connect with the first two bracts respectively: the cotyledonary bundles may be two, in which case they behave exactly as do the corresponding bundles in triarch species; or they may be more than two, in which case anastomoses occur below the node. In other large species, however, such as *Pisum sativum* and *P. Jomardi*, the root is triarch, and the structure of the hypocotyl is quite similar to that in such a slender form as *Lathyrus Nissolia*.

The transition phenomena begin a few millimetres below the cotyledons, irrespective of the change of epidermis, and proceed rapidly; the root protoxylem occupies, at the node, a somewhat median position with respect to the metaxylem, so that the transition is incomplete below the cotyledons. The leaf trace behaves a little differently from the cotyledon bundles; its assumption of the centrifugal direction of differentiation takes place rather rapidly at the cotyledonary node, so that in the epicotyl it shows no trace of exarchy; it is curious to notice, however, that it shows signs of doubleness which betray its root origin (cf. *Cæsalpinia sepiaria*, p. 21).

In those cases in which only the first bract-like leaf contributes protoxylem to the root—*i. e.* in the majority of species—it is noteworthy that the xylem trace of the second bract is represented below the cotyledons by *metaxylem* of the central triarch xylem; a study of early stages of development shows that this metaxylem of the second-leaf trace is differentiated next after the three protoxylems in the hypocotyledonary axis, and before the tangential metaxylems whose fate is to form the *faisceaux réparateurs*. From this condition to that found in tetrarch *Vicia Faba* there is but a small step.

The triarchy found in this tribe must be carefully distinguished from that seen in so many epigeal Trifolieæ, Loteæ, Galegeæ, and Hedysareæ, in which all the root protoxylems are cotyledonary. It is not justifiable to seriate the

Vicieæ with such a species as *Medicago falcata*, as Gérard (1881, p. 348) has done. This subject will be discussed below (p. 107).

So short is the hypocotyl in the hypogeal Vicieæ that the terms descriptive of the level of transition here lose their significance almost completely; they are therefore not included in the table.

Abrus precatorius in the form and structure of its seedling, as in many other features, shows a relationship with the Phaseoleæ rather than with the Vicieæ; the root is tetrarch, the protoxylems all cotyledonary, and the transition low.

The peculiar anatomy of the epicotyl in the Vicieæ (except *Abrus* and *Cicer*) is discussed below (p. 93); its derivation from the hypocotyledonary structure is described fully in *Pisum sativum*.

PHASEOLEÆ.

This tribe includes annual and perennial herbs, shrubs, and trees; a large number of the species are climbing plants, a few are erect or prostrate herbs or sub-shrubs, while trees are infrequent (*Erythrina*, *Butea*).

The seeds are often of considerable size; the embryo is curved, except in *Voandzeia subterranea*, where it is straight.

Germination is epigeal or hypogeal; within the limits of single genera both types can be found, e. g. *Phaseolus* and *Erythrina*. Even when epigeal the cotyledons are often very fleshy, scarcely green, are without stomata, and fall off early; their wrinkled non-leaf-like appearance is very characteristic: they are usually, in such cases, attached by a comparatively narrow base to the hypocotyl. This type is found in epigeal species of *Phaseolus* and *Erythrina*. The cotyledons in the Glycininæ are more foliaceous, though they also contain much food reserves.

The seedlings are for the most part remarkable for their size, the hypocotyl being often very stout and, in the epigeal species, long. The smaller seedlings of *Kennedya* spp. have a curious distension of the cortical tissues in the lower half of the hypocotyl, which is thus shaped something like a champagne bottle.

The prevailing type of symmetry is the tetrarch; the root typically contains an almost square xylem star, solid to the centre, with slightly projecting protoxylems at the corners. There are, however, certain well-marked exceptions. In *Canavalia* spp. a pith is present in the root, which is still tetrarch. In a group of cases including the hypogeal *Voandzeia subterranea* and *Erythrina arborescens*, and the epigeal *E. indica*, a pith is present and a number of root-poles greater than four is developed; heptarchy seems to be a frequent type of symmetry in these species, but, as is usual in such cases, some variation occurs in different specimens and at different levels.

In the majority of the tetrarch species, as described by Dodel (1872), Gérard (1881, p. 346), and the present author, all four root xylems pass into the cotyledons. This appears to be the case both in epigeal and hypogeal germination. Van Tieghem (1871, p. 219), however, mentions that in the hypogeal *Dolichos lignosus* the two intercotyledonary protoxylems of the root are plumular. In *Voandzeia subterranea*, with a higher symmetry than tetrarch, one or more primary xylems of the root may connect directly with the epicotyl.

A characteristic feature of the seedling is the presence in the intercotyledonary plane of a pair of primordial leaves, whose shape often differs markedly from that of the mature foliage. The vascular supply of each of these leaves is sometimes double; a bundle is inserted on the edge towards the minor axis of each cotyledon trace in the upper part of the hypocotyl; these approach one another in pairs, as they ascend into the epicotyl, and fuse in the intercotyledonary plane; the median bundles of the primordial leaves show, as a result of this origin, a double appearance for some distance along the first internode. (See *Phaseolus Hernandesii.*)

The transition is of a characteristic type in the larger Phaseoleæ; it has been thoroughly described by Dodel (1872). A feature of frequent occurrence is the presence in the hypocotyl of a certain number of cotyledonary intercalated bundles or Zwischenstränge; these take their origin in the zone of precocious secondary thickening developed at the collet region in relation to the much-branched roots, and do not form primary connections with the main root. Similar structures have also been observed in *Abrus precatorius* and in the Dalbergieæ, a closely allied tribe.

Tannin-sacs are very abundant in the hypocotyl of most species; *Canavalia* is, however, without them. Primary phloem fibres are also widely distributed. The level of transition is low in the large Phaseolineæ, Diocleinæ, and Erythrininæ; in other more slender species it is intermediate or intermediate-low.

The tribe shows certain analogies with the Cæsalpinioideæ in the form and structure of its seedlings. In both groups we find epi- and hypogeal germination; opposite primordial leaves; large and medium-sized seedlings; occasionally a considerable distension of the lower half of the hypocotyl; prevalent tetrarchy with occasional instances of higher types of symmetry; low transitions in the larger, and somewhat higher transitions in the smaller seedlings; occasional plumular traces in the root; and sometimes signs of doubleness in the vascular supply of the primordial leaves. On the other hand, the prevailing habit of growth is very different in the two groups.

PART C.

GENERAL DISCUSSION.

INTRODUCTORY.

Diverse views are expressed by different writers on the value of seedling anatomy as an index to phylogeny. While some authors are disposed to the opinion that "it is not justifiable to use the seedling structure as an indication of phylogenetic connections" (de Fraine, 1910, p. 175), others, for example Sargant (1903, p. 5), base far-reaching conclusions on the resemblances found in certain cases between the seedling anatomy of species from distinct families. It is necessary to treat such evidence with caution, for vascular anatomy stands in a very intimate relation with physiological needs; and except in cases of obviously vestigial characters there is usually an explanation alternative to that of relationship and heredity. In all discussions of kinship as indicated by anatomy it is essential to distinguish the cenogenetic from the palingenetic; and not until the possibility of a direct explanation in terms of physiology has been dealt with can we safely ascribe resemblances to the conservative influence of heredity.

In the morphology of seedlings we find a singular uniformity which contrasts sharply with the multiformity of habit of the mature plant. In the anatomy, too, there is usually no indication in the seedling of the peculiarities of specific structure which will be exhibited in later life. This is a striking phenomenon in the Leguminosæ, and with certain exceptions, *e. g.* the Cactaceæ (Ganong, 1898; de Fraine, 1910), appears to be a general rule. Two problems are involved, one with regard to morphology, the other to anatomy. The morphological problem is how far the uniformity of the seedling form reflects the uniformity of environment and physiological needs in embryology and early life, and how far it is reminiscent of an ancestral type. The answer to this question has almost invariably been to ascribe almost everything to the former alternative. Not so in the case of the similar anatomical problem. It is confidently expected in some quarters that ontogeny in vascular structure will prove to repeat phylogeny, and that in seedlings anatomical resemblances are likely to indicate relationship between species on divergent branches of a family tree.

It must be admitted that such a prospect is highly improbable, and the search for phylogenetic relationships through the medium of seedling anatomy a forlorn hope. We are confronted by the relative unreliability of vascular anatomy as a key to phylogeny; and by the admitted fact that the seedling morphology of the Phanerogams owes its uniformity to similar cenogenetic influences. The problem is not the same for the Phanerogams as for such a group as the Filicineæ, for instance, where the juvenile anatomy has yielded results of such great phylogenetic value. In the Filicineæ there is no such break in ontogeny as occurs between the unfolding of the Phanerogamic seedling and the growth of the epicotyl. In the Phanerogams the plant hardly begins to "live its own life" until the development of the plumule; the seedling is comparable with the larva of an insect, with habits and structure distinct from those of the mature organism.

In the present state of our knowledge of anatomy, however, *à priori* arguments count for little. It is impossible to decide how much weight to give to a fact employed as a phylogenetic criterion unless its dependence on adaptation or the direct influence of the environment is taken into account. This paper aims at elucidating some of the relations which obtain between the anatomy of a seedling on the one hand and its size, the relative development of its parts, &c. on the other. It thus tends to sift out palingenetic from cenogenetic influences, and to provide a surer basis for the discussion of apparent relationships between different species in respect of their seedling anatomy.

THE NATURE OF THE HYPOCOTYL.

The hypocotyl is a serious stumbling-block to rigid morphologists, and various views have been put forward as to its nature and characteristics. The point of view to which the writer has been led must be briefly explained.

No exact definition of the hypocotyl as a morphological entity is to be anticipated; even the root and stem, between which the hypocotyl is intermediate, have never been defined unequivocally. If we take a broad view of the evolution of plant-members we are compelled to regard the hypocotyl, not as a new intercalated organ, but simply as a segment of the primitive axis. Its peculiarities are due to its position as intermediary between root and stem. The primitive protostele of the whole axis of many Filicales, Sphenophyllales, &c. has its representative in the root only of Angiosperms; the vascular system of the stem has undergone considerable evolution. As we ascend the continuous axis from root to stem, we pass from a primitive to an advanced vascular structure, traversing a region of intermediate complexity on the way. This region represents (Chauveaud, 1911, p. 433) an intermediate stage of vascular evolution; just as does, for instance, the solenostele in the passage from protostely to dictyostely in the ontogeny and phylogeny of certain ferns.

This transition in the Phanerogams is bound up with the vascular supply of the cotyledons and leaves, just as in the Filicales, but the axis may be considered to a large extent independently of the leaves in both cases.

We find that in many cases the transition from root-structure to stem-structure is localised in the portion of the axis between the collet and the base of the cotyledons—*i. e.* the region which is here, for descriptive purposes, termed the hypocotyl. In numerous instances, however, the transition occurs below the collet: occasionally intermediate structure is found above the base of the cotyledons (e. g. *Cæsalpinia sepiaria*). That is, there is no essential connection between the hypocotyl and the transition phenomena; and we shall show later that the level of transition is primarily under the control of a factor of size. Moreover, the hypocotyl may be non-existent; in many hypogeal seedlings the collet coincides with the base of the cotyledons; and occasionally the change of surface-layer even occurs on the petioles of the cotyledons, some distance above the node.

We are justified, therefore, in considering that the hypocotyl, when existent, owes its prominence and peculiar features to its position in relation to stem and root, to the ground-level, and to its connection with the seed-leaves. It seems to be best regarded, not as a stem- nor as a root-structure, nor as a compound organ partly composed of stem partly of root, nor as a plant-member *sui generis*; but as a specialised region of a primitively undifferentiated axis.

Hypogeal and Epigeal Germination.

The distribution of these two types of germination through the Leguminosæ is of interest. Of the two most primitive tribes the Sophoreæ appear to contain a majority of hypogeal species, while the Podalyrieæ are, so far as known, exclusively epigeal. The Vicieæ are hypogeal, with the exception of *Abrus precatorius* (? other *Abrus* spp.), an anomalous member of this tribe. The Genisteæ, Galegeæ, Loteæ, Trifolieæ, and Dalbergieæ are almost uniformly epigeal, and so are the Hedysareæ, with the partial exception of *Arachis hypogæa*. The only other tribe of Papilionatæ, viz. Phaseoleæ, shows both types in abundance. Among the sub-orders Mimosoideæ and Cæsalpinioideæ the epigeal type prevails, but hypogeal germination occurs in some cases, especially in the tribes Ingeæ and Eu-Cæsalpinieæ; while in the Bauhinieæ several species seem to be intermediate in type.

In several instances hypo- and epigeal germinations occur within the limits of a single genus, as in *Pithecolobium*, *Cæsalpinia*, *Sophora*, *Phaseolus*, *Erythrina*, &c.

It thus appears that the distinction between epi- and hypogeal germination is easily overstepped, and that the change has occurred repeatedly in the evolution of the Leguminosæ in particular and of the Phanerogams in general. The difference between the two types is apparently not dependent on the absolute size of the cotyledons; for certain species of *Sophora* with small cotyledons are hypogeal, while many of the Amherstieæ, &c., with large cotyledons are epigeal; moreover, within the Vicieæ, which are almost exclusively hypogeal, a great variation in size is found. Probably the difference depends on the magnitude of some such ratio as

$$\frac{\text{bulk of cotyledons}}{\text{diameter of hypocotyl}}:$$

when this ratio is above a certain limit the germination is hypogeal; when below this limit, epigeal.

The question as to which type is to be regarded as the more primitive probably cannot receive the same answer in all cases; the frequency of the change from one to the other renders this unlikely *à priori*. Moreover, everything depends on what group is selected as a starting-point. If we go back to the Pteridophyta we find no signs of hypogeal germination, for the so-called cotyledons are neither absorbing nor storage organs. Among the Gymnosperms specialisation of function has occurred in the cotyledons, and both types occur in plenty.

Almost all the various families of Gymnosperms have been regarded as primitive by different writers. There seems, however, to be a wide agreement that the Gnetales, Abietineæ, Taxodiinæ, and Cupressineæ are relatively advanced, and it is noteworthy that it is in these groups that epigeal germination preponderates *. The Taxaceæ, whose phylogenetic position is very doubtful, are imperfectly studied, but both types of germination occur †. The Araucarinæ ‡, Cycadales §, and Ginkgoales ‖ show many undoubtedly primitive characters, and here we find hypogeal germination occurring regularly. *Araucaria* § *Eutacta* is the only exception, so far as known.

While the distribution of types among the Gymnosperms would indicate that hypogeal germination is primitive, it must be noticed that there is direct evidence in the Cycads and *Ginkgo* that it is a condition derived from the epigeal type ¶. There is no reason to assume that the epigeal type of the Abietineæ, &c., was derived from hypogeal ancestry: it seems preferable to regard the hypogeal germination in Cycads, *Ginkgo*, *Araucaria* § *Colymbea*, and *Torreya* as specialised in relation to food-storage.

It seems probable that in some cases epigeal germination has been derived from hypogeal. For instance, *Phaseolus multiflorus* is hypogeal; *P. vulgaris*, though epigeal, has cotyledons that do not expand and show only feeble development of chlorophyll *.

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* Hill and de Fraine (1908–1910). [Also the next four footnotes.]

† Chick (1903, p. 83).

‡ Seward & Ford (1906, p. 321); Shaw (1909).

§ Matte (1904, p. 330); Dorety (1908, p. 206); Thomas (1907, p. 81); Thiessen (1908, p. 368).

‖ Thomas (1907, p. 83); Sprecher (1907, p. 16); Seward & Gowan (1900, p. 115).

¶ Wigglesworth (1903, p. 789).

We may conclude that the limits between hypogeal and epigeal germination are easily transgressed in either direction; that the question whether, in any particular case, the type of germination is primitive or derived must be judged upon its own merits; and that the difference probably depends rather on proximate causes than on hereditary conformity to an ancestral type.

THE EPICOTYL IN THE VICIEÆ.

The structure of the epicotyl in the majority of the hypogeal Vicieæ (except *Cicer arietinum*) shows a number of peculiar features which have attracted the attention of many anatomists. These are as follows:—

(i.) The presence of a cortical system of bundles running down the four ridges of the quadrangular stem. In the two ridges in the plane of the distichous leaves, *i.e.*, in the intercotyledonary plane, run stout strands of thick-walled fibres. In each of the lateral ridges, in the plane of the stipules, runs a collateral fibrovascular bundle consisting of a small group of xylem and phloem in the normal orientation, often slightly increased by a cambium, and a group of fibres external to the phloem, each bundle being enclosed by an endodermis. The fibre bundles enter the leaf midrib, and the lateral fibrovascular bundles chiefly supply the large leafy stipules. The course of these bundles has received much attention and has been thoroughly elucidated †.

(ii.) The presence, in the lowest 1-4 internodes, of a solid central core of primary xylem, and the absence of pith. In the higher internodes this central xylem strand is absent. This anomalous structure has received more than one interpretation. Mlle. Sophie Goldsmith (1876), who studied the seedling of *Vicia sativa* with great care, found that the central xylem is formed in a centripetal direction, differentiation commencing at the foci of the elliptical procambium strand and proceeding in all directions; thus forming also the centrifugal median xylem bundles of the leaves. She remarks (p. 43): "die Entwickelung der primordialen Vasalstränge in den untern Stengelinternodien kann eine centripetal-centrifugale sein und dadurch einen Mittelcharakter zwischen den streng centripetalen Wurzel- und den centrifugalen Stengelsträngen bekunden." She offers no theory to explain the presence of the centripetal xylem in the epicotyl, nor does she describe its connection with the root xylem. Gérard (1881, p. 351) examined *Ervum Lens* and other Vicieæ, and came to the conclusion that the centripetal mass of xylem is the upward prolongation of the deeper part of the triarch root star, the outer portions of which alone enter the cotyledons and the first leaf. He considered that this "root-structure" in the epicotyl is an example of a transition prolonged beyond its ordinary limits. Tourneux (1910, p. 325) considered that the centripetal wood should not be regarded as a residue from the root; and suggested that it is a relic of the primitive condition of the xylem found in the stems of many Gymnosperms and Cryptogams. This theory is the only one hitherto advanced which attempts to explain the centripetal xylem in a phylogenetic fashion, and it is in many ways attractive. The description by Scott (1902) of the gradual change from exarchy to endarchy in the wood of the Pteridospermæ, taken together with Chauveaud's demonstration (1911, p. 259) that the protoxylem of stem and leaf in the Angiosperms is not primitive in the same sense as that in the root, leads to an interpretation of the stem, hypocotyl, and root as differentiated parts of the same primitive axis with exarch development of the xylem. On this view the appearance of centripetal xylem in a stem would be merely a phenomenon of reversion to a more primitive type of axis, a type now normal only in the root and to some extent in the hypocotyl.

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* Tschermak (1904) showed that in *Phaseolus* hypogeal germination behaves as a Mendelian dominant to epigeal; and as in most instances the phylogenetically older character is dominant to the younger, this may be taken as confirmatory of the primitiveness of hypogeal germination in this case.

† See especially Goldsmith, 1876; also Lestiboudois, 1848, p. 19; Nägeli, 1858, p. 85; Van Tieghem, 1884, p. 133 (deals with fibro-vascular bundles only, and neglects the fibre bundles); Hérail, 1885, p. 218 (mentions that *Cicer arietinum*, an aberrant member of the tribe, is without cortical bundles).

A great objection to the adoption of this view in the case of the Vicieæ lies in the highly advanced character of the group, and the absence of other signs of primitiveness. Moreover, in no other more primitive Angiosperm has true centripetal xylem been discovered in the stem. Thus it appears difficult to ascribe phylogenetic significance to the presence of centripetal xylem in the stem of the Vicieæ. It is more probable that the structure in question is cenogenetic, and that an explanation should be sought in the recent needs of the plant rather than in an assumed reversion to an ancestral condition.

It appears to the present author that a more probable explanation of the central xylem core can be found. In the first place, the development of this core is complementary to that of the lateral xylems of the central cylinder; these lateral xylems only appear as distinct entities when the central xylem core is absent. This is found to be the case when the lower and upper internodes of the same species are examined (see, *e. g.*, Mlle. Goldsmith's plate v. figs. 15 & 16), and also in the first internode of *Vicia Faba,* which has a large pith. It is thus suggested that not only are the two kinds of xylem complementary but they are identical, and that the solid xylem core characteristic of the majority of the Vicieæ has arisen simply through the lateral compression of the central cylinder into an elliptical form, and the consequent obliteration of the pith.

It might perhaps be expected that if this were the true explanation protoxylem would be found all along the major axis of the ellipse, marking the line of fusion of the two lateral bundle systems; whereas it is found that the protoxylems are located at the foci of the ellipse *. When we consider protoxylem in the light of its formation and physiological function, however, it seems clear that, if only two groups arise, they would tend to be developed at the foci of an elliptical desmogen strand; these being the points which in an early stage of development would serve as the best distributing centres for water and foodstuffs.

The reasons for this compression of xylems to the centre and obliteration of pith are not far to seek. The typical "stem position" of vascular tissue surrounding a pith is commonly ascribed to the mechanical need of resistance to bending strains; the "root-position," on the other hand, freely allows bending to take place. Since the difference between root-position and stem-position is primarily a mechanical adaptation, it might be expected that plants of the habit of the Vicieæ might show some peculiarities of structure. The majority of the Vicieæ are climbing plants without any assured vertical position; consequently, the part of the plant just above the ground must be flexible. Since the germination is hypogeal, this mechanical need falls upon the first few epicotyledonary internodes, and it is these internodes which exhibit the so-called root-structure †.

The case of *Vicia Faba* supports this view, for here we find that the stem is erect and does not depend upon external supports, while there is never any trace of the "medullary xylem" in the lower internodes. The function of the base of the epicotyl differs from that in the majority of Vicieæ, and necessitates rigidity rather than flexibility ‡.

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* The protoxylems of the central mass are distinct from those of the polar leaf-trace bundles, and are often separate; though frequently they may be continuous and form a single protoxylem group at each focus of the ellipse.

† The only other recorded example of medullary xylem in the vegetative stem of a Phanerogam is that of *Cephalotaxus Koraiana*, described by Rothert (Ber. d. Deutsch. Bot. Ges. xvii. p. 275, 1899). But the physiological function of the centripetal wood here appears to be that of water-storage, and the case is quite unlike that in the Vicieæ.

‡ Since the above account was written the work of Chauveaud (1911) has been published. This author also arrives at the conclusion that the pith is obliterated by the compression of the lateral stelar bundles towards one another (p. 348). He attributes this "rapprochement," however, to the presence of the cortical fibrovascular bundles, an interpretation which fails in the case of *Vicia Faba*, and also in the higher internodes of those species whose lowest internodes possess medullary xylem.

The Level of the Transition.

In the summaries of the characteristics of different sub-orders and tribes reference has repeatedly been made to the correlation which exists between the level of the transition and the dimensions of the seedling. A connection of this kind has been indicated by certain authors, in particular by Gérard (1881, p. 298), who states: "Il y a une certaine rélation, non absolue pourtant, entre le volume de la plantule et la rapidité du passage. Si le diamètre du végétal est étroit, la structure de la tige peut ne s'observer qu'à la base du premier entre-nœud après le départ des cotylédons. . . . . Il est fréquent de rencontrer chez les plantules volumineuses la structure de la tige dans une partie de la tigelle." It is rare, however, to find measurements included in the descriptions of seedling-structure given by earlier writers, and it is now possible for the first time to give numerical expression to the relation between size and structure in the Leguminosæ.

In this paper transitions are classified roughly according to level, as low, intermediate-low, intermediate, intermediate-high, and high (see p. 66). In the Summary List the facts for the level of transition are displayed side by side with the measurements of length and diameter of the hypocotyl and the dimensions of the cotyledons. (There will be little said about the size of cotyledons, and the data are included chiefly for the sake of completeness.)

It is thus a matter of arithmetic to find the average diameter and length of hypocotyl for each of the five classes of transition. The results of the calculations are given in the following table:—

	I.	II.	III.	IV.	V.	VI.
	Level of Transition.	Number of Species.	Average length of hypocotyl (L).	Average diameter of hypocotyl.		Average volume of hypocotyl, $\pi L\left(\frac{R+r}{2}\right)^2$.
				At base (2R).	At summit (2r).	
	Low	30–32	40·7	2·85	2·52	229·6
Middle	Intermediate-Low	21	26·0	1·30	1·02	27·5
	Intermediate	21	21·2	1·24	1·01	20·9
	Intermediate-High	10	20·9	1·16	1·02	19·2
	Middle (total)	52	23·1	1·25	1·02	23·6
	High	34–36	16·5	0·85	0·75	8·3

In column I. is given the class of transition-level. In column II. is placed the number of epigeal species recorded in the Summary List from which the calculations are made *. The average length of hypocotyl for each class is given in column III. In the next two columns are given the average diameters at base and summit of hypocotyl. The numbers refer to millimetres in columns II.–V. In column VI. the results of a further calculation are exhibited, the object of which is to obtain a rough estimate of the volume in cubic millimetres of the average hypocotyl in each class; the assumption being made that the hypocotyl is cylindrical.

It is seen at once that the order of lowness of transition is also the order of magnitude of length, diameter, and volume of the hypocotyl. The lower the transition the greater the average dimensions of the hypocotyl. The parallelism is exact in all respects (save for a trifling discrepancy in column V.), but the results for volume given in column VI. are especially striking.

In view of these results there can be no doubt that the level of transition is intimately connected with the absolute size of the hypocotyl. While such a conclusion may be only partially justified in the case of the three "middle" transitions, it is amply proven in the three main grades of level.

Further, it is evident which of the two related characters must be regarded as cause and which as effect. The vascular system admittedly responds to change of external size and form, but it is almost inconceivable that structure should act as a cause determining size.

We must therefore ask whether it is the length, the diameter, or the bulk of the hypocotyl which regulates the level of the anatomical transition.

There is much to show that it is mainly the diameter (or more precisely the area of cross-section) which determines the level of transition. An inspection of the data in the Summary List reveals the fact that the length of hypocotyl for a given level of transition fluctuates on the whole within wider limits than the diameter. Then, again, it is clear that the length of the hypocotyl can have no direct bearing on the cases of very low transition completed below the collet. As a matter of fact, we find low transitions in seedlings whose hypocotyls vary in length from 5 to 110 mm. Further, the phenomena of transition are so often associated with the region of the collet where a dilation of the axis occurs, that a direct connection between them and the diameter may be confidently assumed. The impression given in studying such cases is that the stele takes the opportunity afforded by the increased diameter to acquire a pith and expand. Where the diameter is small the stele perforce remains root-like and without pith until it actually divides in half to supply the cotyledons. There are certain exceptions to this correlation, however, which are difficult to explain. The most striking of these is, perhaps, the case of *Lotus Tetragonolobus*, where we find an intermediate-high transition with a diameter of 1·9 mm. Here it seems necessary to call to our aid a hereditary factor, high and intermediate-high transitions being the general rule in the Loteæ.

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* When two numbers appear, it implies that the first number refers to the species whose length, the second to those whose diameter, was estimated.

What, then, is the nature of the apparent correlation between the *length* of the hypocotyl and the level of transition? It appears that this correlation is secondary, and follows from the fact that in the majority of seedlings there exists a rough proportionality between length and diameter. There appears to be an average type of form for the epigeal Leguminous seedling: if the diameter be increased the length tends to be increased in the same ratio. We can demonstrate this tendency by a comparison of columns III. and IV. in the table, when it is seen that in each class of seedlings the length of the hypocotyl is 14–20 times the diameter at its base, the average ratio for the 120 epigeal seedlings being $L/2R=17$. This being so, it is clear that a correlation of transition-level with diameter will also appear as a correlation with length.

It follows that the figures quoted in column VI. of the table merely emphasise those in columns IV. and V. without adding anything new to the discussion.

In a few cases, however, the length of the hypocotyl may have a direct effect upon the classification of transition-levels itself; this is especially the case in middle transitions. If the hypocotyl be short there is less room for the transition than if long, and in consequence the changes may apparently take place at a higher level, relatively to the collet and cotyledonary node. (See, for instance, *Scorpiurus sulcata* and *S. vermiculatus*, p. 85, and certain Genisteæ, p. 80.) This cause has probably contributed to the relative vagueness of the classification of middle transitions.

THE LEVEL OF TRANSITION AND THE MATURE HABIT.

The Summary List reveals the fact that all those species which show the tree-habit have low or intermediate-low transitions: out of 20 epigeal species of trees ("shrubs or small trees" excluded) 14 show a low, 6 an intermediate-low transition. On the other hand, the herbaceous habit appears to be associated with a high transition, though not so strictly: out of 55 epigeal herbs 28 showed a high transition, 6 an intermediate-high, 9 intermediate, 3 intermediate-low, and 9 low (of which 7 are Phaseoleæ).

There is thus some foundation for the belief that the mature habit is correlated with the level of transition. But in view of the connection which exists between the transition-level and the diameter of the hypocotyl (p. 97), it appears probable that the correlation with habit is not an example of direct cause and effect. As a matter of fact, it will be shown later that this correlation is due to a tendency on the part of trees to produce large seeds and consequently large seedlings, and for the other types of plants to produce small seeds and seedlings (p. 109).

The Level of Transition and Phylogeny.

The view is held in certain quarters that the level of transition is probably of value in phylogenetic discussion. Tansley & Thomas (1906, p. 763) state that "It seems that a high transition, typical of Gymnosperms and very many Dicotyledons, is probably primitive. . . . . Stem structure of the hypocotyl has apparently been acquired. . . . ."

The results of the previous sections, however, throw great doubt on this theory, for though they only apply strictly to the Leguminosæ, yet there is much probability that similar principles are in operation outside this family. It is necessary to eliminate the influence of size before the transition-level can become a phylogenetic criterion. Unfortunately, records of the size of the seedlings hitherto studied are deficient, and so comparisons are hampered. It is noteworthy, however, that in the Coniferæ with high transitions the diameter of the hypocotyl is often small, at least at the summit, as shown in Hill & de Fraine's figures (1908, I. pl. 35); while *Libocedrus decurrens*, with an intermediate transition (as gathered from the description), is shown with a hypocotyl 2·0 mm. in diameter. It is clear that the ascription of a high transition to the Cycads, in which the seedling is usually large, rests on a misconception; for though "the hypocotyl throughout the greater part of its length shows a root-structure" (Hill & de Fraine, 1909, III. p. 455), yet "it is obvious from the strongly mesarch nature of the cotyledonary bundles . . . . . that only a slight amount of re-arrangement is necessary in order to bring the protoxylem into its exarch position" (*loc. cit.* p. 441) *. In *Araucaria Cunninghamii* it is stated that "the actual transition takes place very slowly" (Hill & de Fraine, 1909, II. p. 214), and the same is the case in *A. imbricata* and *A. Bidwillii* (Seward & Ford, 1906; Shaw, 1909). In the Gnetales "the transition to root-structure takes place in the lower region of the hypocotyl" (Hill & de Fraine, 1910, IV. p. 331).

Thus it appears that the Gymnosperms should not be quoted as exhibiting characteristically a high transition comparable to that found in the Dicotyledons.

Since it has been shown that cenogenetic preponderate over palingenetic influences in determining the level of transition of the Leguminosæ, and since the basis among the Gymnosperms of the theory of the phylogenetic value of this character is found to be unsound, we are justified in deciding against the view expressed by Tansley & Thomas and quoted above.

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* It must be noted that these authors trace the structure downwards, from cotyledons to root.

It must be noted, however, that in one or two instances in the Leguminosæ cenogenetic explanations apparently fail, and the only alternative is an appeal to heredity. This is the case in *Lotus Tetragonolobus*, and may perhaps also apply to *Trigonella cretica* and *Desmodium canadense* (pp. 81, 82, 85). But apart from these instances, there is little support for a view which depends on the hereditary fixity of the level of transition.

THE TYPE OF SYMMETRY.

The problem as to what determines the number of protoxylem groups in the hypocotyledonary axis is beset with difficulties, and a general solution cannot be expected in the present position of our knowledge. In the Leguminosæ, however, some light can be thrown upon the subject, as certain correlations are found to exist between the type of symmetry and other characters of the seedling.

In the first place, it appears that the characteristic type of symmetry in the Leguminosæ is the tetrarch. Among the 203 entries in column VII. of the Summary List tetrarchy is mentioned in 123 cases, as occurring at least in some specimens or in some part of the hypocotyledonary axis. Of the other 80 entries, a great number are simply records of diarchy or triarchy in the root, and a further investigation would probably reveal a tetrarch phase in many of these cases also; the Genisteæ, however, are typically diarch and the Vicieæ typically triarch (see pp. 79, 85). In particular the Cæsalpinioideæ and Mimosoideæ are characteristically tetrarch, there being no well-ascertained example in which tetrarchy has not been found. It may be remarked that as the great majority of the trees are members of these two sub-orders, there also appears to be a correlation between the tree-habit and tetrarchy, the significance of which will be considered below (p. 115).

Again, it is evident from a study of the Summary List that in some alliances the type of symmetry is remarkably constant: this is the case in the Mimosoideæ, Cæsalpinioideæ, and Phaseoleæ, where tetrarchy is the rule, Genisteæ, which are uniformly diarch, and the hypogeal climbing Vicieæ, which have a peculiar form of triarchy. In other groups, on the contrary, there is great variability of type, this applying to whole tribes, genera, species, individuals, and parts of the same individual; the Trifolieæ, Loteæ, Galegeæ, and Hedysareæ show this variability very strikingly—a variability that seems to circle round the unstable type of triarchy found in epigeal seedlings.

Clearly, then, tetrarchy, characteristic of the Leguminosæ, exists in two forms, stable and unstable. What is the basis of this difference?

The answer to this question can only be given after certain other problems have been considered, the most important of which is the relation of plumular traces to the vascular structure of the hypocotyl.

Plumular Traces in Hypocotyl and Root.

In the vast majority of epigeal seedlings it is found that the primary vascular system of the cotyledons, hypocotyl, and root is complete in itself; all the protoxylem strands contained in the root pass up into the cotyledons *, and a primary or, as it has been called, fœtal or larval circulation is established in the seedling without reference to subsequent plumular developments. When the plumule develops in such cases (and there is frequently a marked pause between the unfolding of the seed-leaves and the first foliage leaf, when compared with the ordinary succession of foliage-leaves), its vascular system is simply superposed upon that of the typical morphological constituents of the seedling. In most epigeal types the hypocotyl has lost the capacity for forming primary xylem before the plumule begins activity; and therefore the plumular traces are represented in the hypocotyl by secondary xylem only.

In a considerable number of large epigeal seedlings, however, the plumule begins to grow before the hypocotyl has completed its phase of elongation; and in such cases tracts of primary xylem are differentiated from the desmogen strands common to plumule and hypocotyl; in fact the plumular traces are represented in the hypocotyl by primary xylem. Such primary xylem, however, usually stops short in the hypocotyl and is not prolonged into the root. This type of connection is found, for instance, in many Phaseoleæ.

In other cases, particularly when germination is hypogeal, the plumule has already attained a considerable size while in the embryo; and on germination its development is rapid. The hypocotyl remains short, and primary xylem is developed in continuous strands between the root and epicotyl. The degree to which this connection is made varies in different cases, often simply as the result of the varying precocity of plumular development. A series of cases is here given, illustrating the various degrees of connection between epicotyledonary and hypocotyledonary axes.

(*a*) Plumular traces represented in hypocotyl and root by secondary xylem only. (Most small epigeal seedlings).

(*b*) Plumular traces represented in the hypocotyl by primary, in the the root by secondary, xylem. (Phaseoleæ spp.)

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* Unless, of course, some of them disappear on the way.

(*c*) Traces from the first epicotyledonary node represented in the root by metaxylem. (*Sophora* spp.)

(*d*) Traces from the first epicotyledonary node represented in the root by proto- and metaxylem. (*Pithecolobium Unguis-cati*, *Cæsalpinia sepiaria.*)

(*e*) Traces from the first epicotyledonary node represented in the root by proto- and metaxylem, from the second by metaxylem. (Many Vicieæ.)

(*f*) Traces from the first two epicotyledonary nodes represented in the root by proto- and metaxylem. (*Vicia Faba.*)

Let us consider the first type of connection more closely. It is in this type that the natural distinction between the vascular systems of seedling and epicotyl is most pronounced; and consequently it is here, if anywhere, that we should expect to find special devices with the object of bringing the two systems more into physiological connection with one another. Now in the case of a tetrarch seedling the two lateral protoxylems lie immediately beneath the main vascular bundles of the first two leaves, which are almost invariably produced in the intercotyledonary plane; and consequently it is these xylems which are most closely *en rapport* with the young hypocotyl. Hence it is in the intercotyledonary xylems that we should look for indications of the effect of the plumule in modifying the structure of the hypocotyl. As a matter of fact, in the slender epigeal seedlings so abundant in the Trifolieæ, Loteæ, Galegeæ, and Hedysareæ we find the polar xylems constantly present; while the lateral xylems exhibit a great amount of variation, even within the same hypocotyl, diarchy, triarchy, and tetrarchy occurring within very limited circles of affinity. Moreover, we find in these same groups that the form of the cotyledon trace differs very little whatever be the symmetry of the hypocotyl. The lateral root-poles almost always diminish in importance as they ascend the hypocotyl; and in a few cases they die out completely towards its summit instead of entering the cotyledons.

The conclusion is irresistible that the variations exhibited by the intercotyledonary xylems stand in an intimate relation to the first foliage leaves: and we proceed to enquire what is the nature of this relation.

Two alternatives present themselves, viz.:—(i.) The plumular traces may tend to replace the intercotyledonary root-poles, or *vice versâ*, their relation to one another being *complementary* and one of supplantation. (ii.) The intercotyledonary xylem may combine with the leaf trace to form a joint conducting channel, their relation to one another being *supplementary*.

The first theory was originally formulated by Miss Sargant (1903, p. 61), and has been adopted by Miss Thomas (1907, p. 84). On this view the diarch type of structure is regarded as being derived from the tetrarch, the change being correlated with the early production of foliage-leaves. *Casuarina* and *Cassytha*, for instance, are considered to have "escaped anatomical reduction [from tetrarchy to diarchy] on account of the insignificance of the plumular traces" (Thomas, 1907, p. 86). A replacement of primary by secondary xylem is thus supposed to have occurred in the change from tetrarchy to diarchy; the increase in the amount of secondary tissue being due to accelerated epicotyledonary development.

When we attempt to apply this theory to cases of triarchy we are met by a serious difficulty. If it be granted that triarchy is an intermediate stage in the course of reduction from tetrarchy to diarchy (and this seems inevitable, once admitting the reduction hypothesis), we should expect on Miss Sargant's theory that the first pole to be lost would be the one opposite the greatest development of secondary xylem, *i.e.*, the one on the side of the first leaf. Now the reverse of this proves to be the case in almost all the triarch epigeal Leguminosæ examined *. The lateral protoxylem to be developed in the hypocotyledonary axis in cases of triarchy is the one on the side of which the first foliage leaf arises; and in those triarch seedlings in which a rudimentary fourth xylem appears, this is on the side of the second leaf.

It is clear that these facts cannot be explained on Miss Sargant's reduction theory of the replacement of primary by secondary xylem in the intercotyledonary plane in response to accelerated plumular growth. On the contrary, they strongly support the alternative theory, by which the plumular trace and the lateral root xylem are regarded as supplementary; the relation between them is seen not to be one of supplantation, but one of joint participation in the early formation of a continuous conducting channel from root to leaf.

If it be true that the plumular traces enter into a very close relation with the intercotyledonary root-poles we ought never to find triarchy in cases in which the first two plumular leaves are opposite (though the reverse proposition is not equally true). An examination of all the cases of triarchy occurring in the Papilionatæ shows that in every known instance the first two leaves are alternate †. This is specially noteworthy in the Galegeæ and Hedysareæ, for here we find certain genera with opposite primordial leaves and tetrarchy (*Indigofera, Psoralea, Desmodium*); others with alternate leaves and triarchy (*Astragalus, Caragana, Hippocrepis*).

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* In some triarch seedlings more than one epicotyledonary axis arises at the node (e.g. *Scorpiurus sulcata*), but one is stronger than the others.

† *Lotus corniculatus* is exceptional in that the first internode is much elongated (a feature mentioned by De Candolle (1825, p. 89) in other *Lotus* spp.) and the first two leaves quite close together. In this species the first leaf trace appears (? always) on the side opposite to the third xylem, this being a definite exception to the rule.

Further, it may be observed that in those triarch cases where the cotyledons are markedly asymmetrical (p. 77) the third root xylem is on the side of the narrower halves of the cotyledons, which thus receive the greater vascular supply. In fact it appears that triarchy exists in spite of the asymmetry of the cotyledons and not in connection therewith.

We may therefore conclude with some certainty that in slender epigeal seedlings the lateral root-poles, when developed, stand in a far more intimate relation to the plumular traces than they do to the cotyledons ; and, further, that this relation is not complementary but supplementary.

We must therefore distinguish between the two different rôles which the intercotyledonary primary xylems of the hypocotyl play in relation to the plumule. They may either (i.) form a continuous primary connection from root to leaf without relation to the cotyledons ; or (ii.) they may be part of the cotyledonary vascular system, but have a more intimate supplementary physiological relation with the plumular traces.

The intercotyledonary xylems may also play another part, which will be discussed in the next section.

TETRARCHY.

In many cases of tetrarchy in slender epigeal seedlings of the tribes Trifolieæ, Loteæ, Galegeæ, and Hedysareæ, we have seen that the lateral root-poles in function mainly supplement the earliest plumular traces. In some cases (e. g. *Melilotus arvensis*, *Chorizema cordatum*) it has been shown that the lateral xylems never enter the cotyledons, but die out in the upper part of the hypocotyl. We therefore enquire the reason why, in the majority of instances, the lateral xylems though plumular in function yet pass into the cotyledons.

In large epigeal seedlings it has been repeatedly shown that the lateral xylems of the tetrarch root bifurcate on passing up the hypocotyl, half of each passing out, without noteworthy reduction in importance, to each cotyledon, where (often after a brief fusion with the products of the polar xylems) they become the lateral bundles of the lamina. In these cases the intercotyledonary xylems play an important part in the vascular system of the seedling ; and whether they later enter into relations with the epicotyl or not, their primary function is to supply the cotyledons. The greater bulk of these seedlings demands a more complex vascular system than is afforded by the polar root xylems, though the latter are adequate in many slender seedlings *.

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* Out of the 28 epigeal species of Leguminosæ the diameter of whose epicotyl is 2·0 mm. or more at the base, and 1·5 mm. or more at the summit, 25 exhibited, at least at some level or in some specimens, a tetrarch symmetry. The exceptions were two species of Genisteæ with diarch, and *Erythrina indica* with heptarch structure.

We can hardly avoid the conclusion that the tetrarchy found in slender seedlings is a reduced form of that found in large seedlings ; its preservation being in relation to the useful function performed by the intercotyledonary root-poles in supplementing the early plumular traces.

Reduction of the Number of Protoxylems.

While there exists an intimate relation between the plumular bundles and the intercotyledonary root-poles, it appears that the latter can readily be dispensed with. Their absence entails the production of a little more secondary xylem in the hypocotyl before root and leaf can be put into direct communication ; so that the diarch type is not at a very pronounced disadvantage as compared with the tetrarch. That some advantage accrues from the possession of intercotyledonary xylems is clear from the occurrence of triarchy ; but we find so many cases in which, within narrow circles of affinity, one or both of the lateral root-poles may be present or absent or vestigial, that we can attribute to them no profound functional significance.

If we assume, as there is good reason to do (p. 104), that the form of tetrarchy in slender seedlings is derived by reduction from tetrarchy in bulky seedlings, it follows that triarchy and diarchy are further stages in the reduction. There seems to be no other explanation for the close association between tetrarchy, triarchy, and diarchy in the slender seedlings of the Trifolieæ, &c., than that we have here a group of plants in an unstable condition with respect to vascular symmetry. The lateral cotyledonary root xylems of the larger tetrarch forms are in the process of vanishing, perhaps in relation to the decrease in bulk of the seedling ; their final disappearance is, however, delayed by the somewhat useful function they subserve with regard to the plumular traces, but this secondary usefulness is too slight to have much influence in checking the evolution towards diarchy.

Tetrarchy, triarchy, and diarchy may co-exist in a single seedling, *e. g.*, in *Ononis rotundifolia*, *Medicago turbinata* (3→4→2), and *Dorycnium hirsutum* (2→3→4). These and many other cases in which only two of the types co-exist show that a decrease in the number of protoxylems may occur in some cases as we *descend* the axis, in other cases as we *ascend* it. A particular lateral xylem may be present in the root and absent in the cotyledons ; it may be present in the cotyledons but unrepresented in the root ; or it may be present in neither cotyledons nor root, but may run a short isolated course in the hypocotyl.

It thus appears that the reduction from tetrarchy may occur at either the top or the bottom of the hypocotyl, and in certain cases at both ends simultaneously. There seems, however, to be a distinct preference for the reduction to take place below rather than above. Out of 26 species of

Leguminoeæ in which change of symmetry is recorded *, 19 show an increase in the number of protoxylems as the hypocotyl is ascended, 5 a decrease, and 2 an increase followed by a decrease. It may be suggested that this preference for reduction below points to the existence of a greater conservative tendency at the cotyledonary node than elsewhere in the axis; or it may simply be an expression of the fact that the axis usually tapers rapidly downwards at the collet region (where the reduction so often occurs)—more rapidly than it tapers upwards at the summit of the hypocotyl.

Whatever be the explanation, it seems unnecessary to ascribe a different significance to basipetal and acropetal modes of reduction: both alike are expressions of the tendency to disappear of the lateral xylems, whose efficiency as cotyledonary conducting channels is similarly restricted whether they end blindly above or below.

We have seen that the change from the stable to the unstable type of tetrarchy is bound up with reduction in size of the seedling and the consequent restriction of the cotyledonary vascular system. It follows that to this prime cause we must also attribute the production of diarchy.

With diarchy we once more enter upon a stable condition of vascular structure. While there is no doubt that diarchy bears a close phylogenetic relationship to the unstable forms of triarchy and tetrarchy, yet it is noticeable that it appears to be less variable than these other types of symmetry. Further, in the Genisteæ diarchy seems to be absolutely constant, no vestige of intercotyledonary xylems ever appearing. Transitions to the Genisteæ-type from tetrarchy are afforded by *Ononis* spp. and the Podalyrieæ; but within the tribe itself, despite notable variations in size and form, the symmetry is immoveably diarch.

This rigidity of diarchy as compared with the plasticity of triarchy and tetrarchy in slender epigeal seedlings can be explained on these lines: the difference between triarchy and tetrarchy is often to be regarded simply as the expression of the alternate or opposite position of the first two leaves; whereas between triarchy and tetrarchy on the one hand, and diarchy on the other, there is the more fundamental question whether or not the plumular traces shall be supplemented by special hypocotyledonary primary xylems at all. The further reduction of diarchy to monarchy seems to be almost out of the question in Dicotyledons.

TRIARCHY.

Having thus traced out a probable reduction series among the types of symmetry common in epigeal seedlings, we next enquire what is the phylogenetic relation to these types of those cases in which the plumular traces contribute primary xylem to the hypocotyl and root. Is the plumular trace to be regarded as a modified intercotyledonary strand, or is it a new structure superposed upon the cotyledonary vascular system?

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* Excluding cases with more than four protoxylems.

We shall see that triarchy, which has already proved so useful a key to phylogeny, enables us partially to answer this question also in a rather unexpected fashion.

Two well-marked types of triarchy occur in the Papilionatæ. In the first or epigeal type, which we have already discussed, all three protoxylems of the root are essentially cotyledonary. In the second type, characteristic of the hypogeal climbing Vicieæ, two protoxylems enter the cotyledons (which are borne at an angle of about 120° from one another), and the third passes up into the first leaf. Can we regard the intercotyledonary xylem as homologous in the two cases? It seems quite clear that we must not do so, for the following reason :—

A comparison between the two types reveals the curious fact that in the epigeal Hedysareæ, Galegeæ, &c., the first leaf is borne on the opposite side of the axis to that on which it is borne in the hypogeal Vicieæ. This becomes clear from a study of the manner in which the embryo is folded in the seed. The radicle is accumbent in both cases, the axis of the embryo being bent. In the Vicieæ the first plumular leaf is borne on the convex side of the bend ; whereas in the epigeal species it is borne on the concave side. This is shown also after germination, for the edges of the cotyledons which were pressed against the radicle and hilum in the seed are often marked by a sinus or straightness which is absent from the external edges. In the hypogeal Vicieæ the first leaf is borne on the side away from this sinus ; in the epigeal Galegeæ, Hedysareæ, &c., on the side towards it.

It follows that the lateral root-pole which is present in the triarch Vicieæ is on the opposite side of the axis to that present in the epigeal cases of triarchy ; and therefore it is out of the question that one type can have been derived phylogenetically from the other by a change in the rôle of the intercotyledonary xylem *.

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* The transition from one type of seedling to the other was very possibly effected through the mediation of forms in which the first two leaves are opposite. The Vicieæ type may have been derived from such a condition as is found in the hypogeal Phaseoleæ where the primordial leaves are opposite; such a plant as *Abrus precatorius*, an anomalous member of the Vicieæ, exhibiting the Phaseoleæ type of seedling. It is noteworthy, too, that forms with opposite first leaves occur in the Galegeæ (*Indigofera*, *Psoralea*) and in the Hedysareæ (*Desmodium*). Moreover, in triarch *Lotus corniculatus* (see p. 103, footnote) the first leaf arises (? always) on the same side as in the Vicieæ, *i. e.*, on the opposite side to the intercotyledonary xylem; but it does not contribute to the primary structure of the hypocotyl. An alternative hypothesis would be to derive the cotyledons and first leaf of the Vicieæ from a tricotyledonous type; in an example of this kind in *Lotus corniculatus*

This is only a partial solution of the problem, however. Two alternatives still remain open, viz.: (i.) The first leaf trace in the triarch Vicieæ is a new structure superposed upon a diarch type. (ii.) The Vicieæ type has arisen by reduction from a tetrarch type, probably with opposite primordial leaves as in the Phaseoleæ, the intercotyledonary xylem retained not being the same one as is kept in the epigeal type, and being converted from a cotyledonary to a plumular function. Between these two alternatives it is difficult to decide ; but the existence of the tetrarch *Abrus* and the closely-allied Phaseoleæ tells in favour of the second. The evidence afforded by *Pithecolobium Unguis-cati* and *Cæsalpinia sepiaria* points in the same direction (cf. *Vicia Faba*) ; while the peculiar case of *Bauhinia racemosa* is hardly evidence for the first alternative. On the other hand, the second explanation involves the conversion of a joint conducting channel composed of plumular secondary xylem superposed on cotyledonary primary xylem into a strand of plumular primary xylem; and this change may seem too radical to be probable; particularly as in the case of epigeal triarchy it has been shown that an active replacement of cotyledonary by plumular xylem does not seem to occur. The first explanation, moreover, is simpler and more attractive than the second ; though it conflicts with the usual rigidity of diarchy. On the whole the balance between the two alternatives appears to be nearly even, with a slight inclination towards the second, viz., the theory of the derivation of the triarch Vicieæ type from tetrarchy by specialisation in the opposite direction to that which has occurred in the epigeal Galegeæ, Hedysareæ, &c., combined and connected with the adoption of hypogeal germination and early plumular development.

Other Types of Symmetry.

In a few instances more than four protoxylems are present in the hypocotyledonary axis. The simplest case is that of *Pithecolobium Saman*, where four new proxytolems are added in the root, alternately with the existing four. This may be simply in connection with the large size of the root in this species ; though other species with equally large roots remain tetrarch.

Another simple case is that of *Bauhinia racemosa*, where it is clear that the hexarch structure of some seedlings is derived from the tetrarch by the interposition of plumular metaxylems (p. 15). In these two cases the tetrarch type appears to be fundamental, the extra complications acquired. In other cases, however, this is not so obvious. In *Voandzeia*

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each cotyledon took one of the poles of the triarch root. The probability of this, however, is too remote for serious consideration.

It may be noted that in the hypogeal Sophoreæ (see Lubbock's figures of *Sophora secundiflora* and *Edwardsia chilensis*, 1892, pp. 452, 453) the first leaf is borne on the same side as in the epigeal Hedysareæ, &c., *i. e.*—on the reverse side to that on which it is borne in the hypogeal Vicieæ.

subterranea, *Castanospermum australe*, *Erythrina arborescens*, *E. indica*, and many specimens of *Vicia Faba* the cotyledons receive complex vascular supplies derived from two to four root-poles. *Vicia Faba* and *Voandzeia subterranea* show certain relations to a tetrarch type ; and the *Erythrina* spp. belong to a tribe which except for them and *Voandzeia* is entirely tetrarch. It thus appears possible that these peculiar types of structure are also derived from the tetrarch type ; the increase in the number of root-poles being almost certainly correlated with the great bulk of the cotyledons in these species, which except for *Erythrina indica* are all hypogeal.

THE RELATIONSHIPS OF THE TYPES OF SYMMETRY.

The result of the foregoing discussion has been to indicate that the stable tetrarch type, as seen in large epigeal seedlings, is probably fundamental and primitive*. The accompanying scheme (p. 110) illustrates the relationships of the different types to one another, and summarises the conclusions reached above.

THE SIZE OF THE SEEDLING.

We have seen in the preceding sections how important a factor is the size of the seedling in determining both the level of transition and the type of symmetry. We can hardly leave the subject here, but must enquire into the causes which determine the size of the seedling.

Given uniform conditions in the seed with respect to the presence or absence of endosperm and perisperm, it appears that the size of the seedling depends directly on the size of the seed. In the Leguminosæ, endosperm is for the most part absent, though in a few cases (*e.g.* Cassieæ) it is present in considerable amount, and in others a small quantity occurs. If we make the assumption that weight of the seed is proportional to its size (as is fairly legitimate within a single family with moderately uniform food-reserves), it is possible to get an indirect estimate of the size of the seedling by weighing the seed.

Now in the Leguminosæ there seems to be a correlation between the tree-habit and the seedling structure. Of the 20 epigeal species of trees whose seedlings have been studied, 18 show a tetrarch symmetry, at least in some part of the axis *. 14 show a low transition, that of the other 6 being intermediate-low. We have already seen (p. 96, and p. 104 footnote) that

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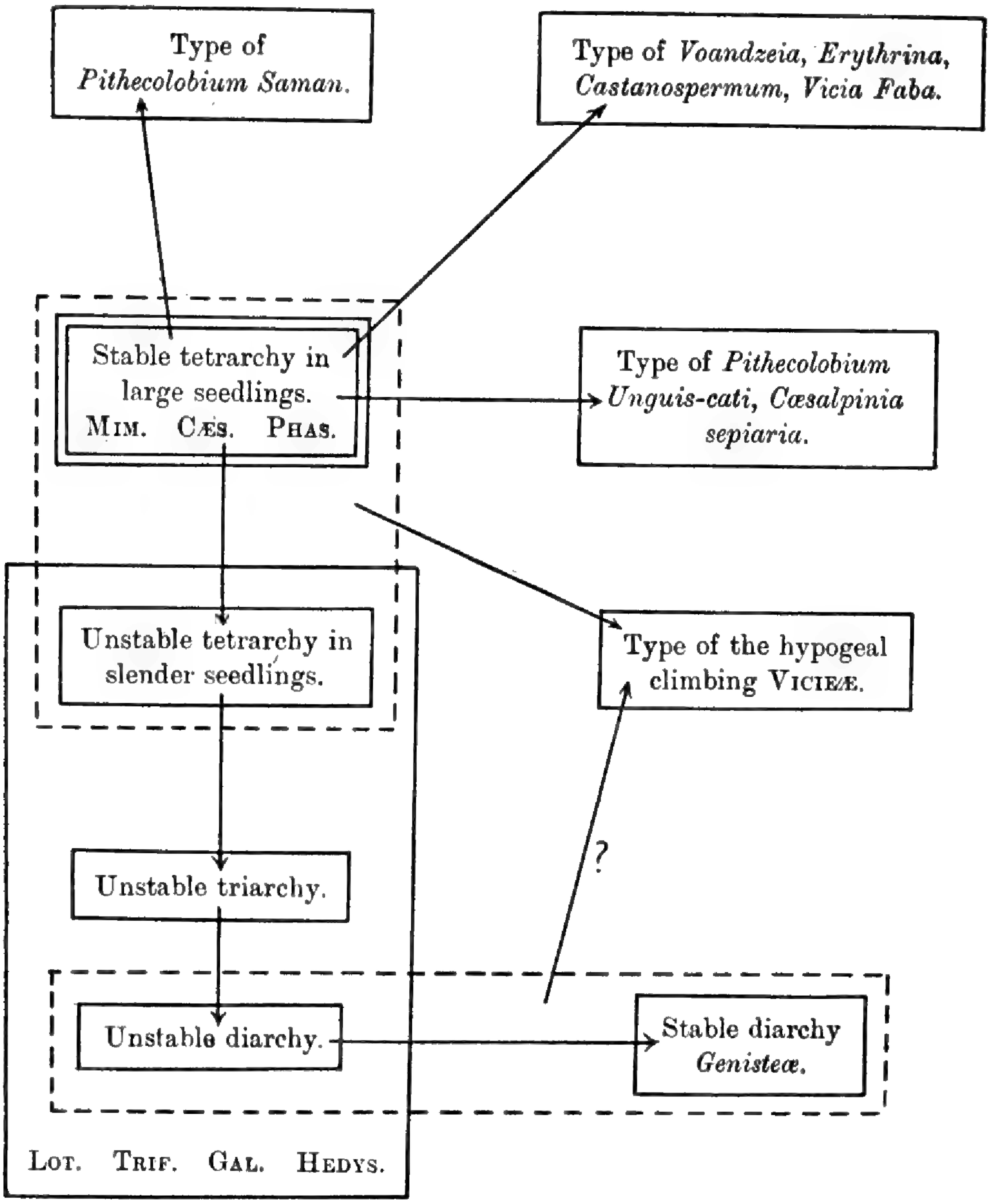
* The primitive nature of tetrarchy has also been supported by Miss Sargant, as a result of her studies of the Liliaceæ, &c. (1903). The *Anemarrhena* type, on which the question turns, appears to be an example of unstable tetrarchy (cf. *Eranthis* and *Podophyllum*, where diarchy is attained lower in the hypocotyl) with extreme reduction of the cotyledonary bundles: it cannot be regarded as primitive among the Dicotyledons, if we accept the view here advocated.

A reduction hypothesis has also been put forward by Mr. Tansley and Miss Thomas (1906).


Type of *Pithecolobium Saman.*
Type of *Voandzeia, Erythrina, Castanospermum, Vicia Faba.*
Stable tetrarchy in large seedlings.
MIM. CÆS. PHAS.
Type of *Pithecolobium Unguis-cati, Cæsalpinia sepiaria.*
Unstable tetrarchy in slender seedlings.
Type of the hypogeal climbing VICIEÆ.
?
Unstable triarchy.
Unstable diarchy.
Stable diarchy *Genisteæ.*
LOT. TRIF. GAL. HEDYS.

these same characters are closely associated with great size in the seedling. If it can be demonstrated that the production of a large seed is correlated with the tree-habit, we shall have an explanation of the preponderance of tetrarchy and low transitions in both cases.

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* The exceptions being *Laburnum vulgare*, one of the fixedly diarch Genisteæ, and *Erythrina indica* exhibiting heptarchy. "Shrubs or small trees" are excluded.

Clearly in many cases no such correlation exists between the tree-habit and the production of large seeds; the examples of *Salix* and *Populus* will at once be recalled. But in these instances there is a high degree of specialisation for wind-dispersal, by means of a minute seed and pappus; and such cases can therefore be excluded. In the Leguminosæ, however, there appears to be comparatively little special adaptation for distribution exhibited by the seeds themselves; the adaptations that occur (and they are very numerous) are almost invariably displayed by the fruit. Sling-fruits are frequent, fleshy, hooked and spiny fruits for animal distribution, and winged or inflated fruits for wind-dispersal also occur; brightly-coloured fleshy caruncles occur on the seeds in several cases, but the distribution of naked seeds by wind-agency is practically unknown in the family. In many cases the seeds are "hard," and seem to be distributed in time rather than in space[*].

The Leguminosæ, therefore, are an eminently suitable family in which to try and discover whether any correlation exists between the mature habit and the size of the seed. In pursuance of this end the seeds of 216 species of Leguminosæ have been weighed, and the results are tabulated below according to the habit of the mature plant. In all cases, except a few of the largest, the average weight of several seeds is recorded. Well-developed dry seeds were chosen for weighing as far as possible. While accuracy cannot be expected in all cases, the results probably indicate more or less correctly the relative magnitude of the seeds of the species examined[†].

The weights are given in grams. Plants cultivated for the sake of their seeds are enclosed in brackets, and are excluded from the final calculation.

Annual Herbs.

Biserrula Pelecinus	·0018	Lupinus linifolius (?)	·1985
Crotalaria pumila	·0050	L. luteus	·1370
Hippocrepis multisiliquosus	·0031	L. micranthus	·0156
Indigofera glandulosa	·0025	L. nanus (var. albococcinea)	·0774
I. linifolia	·0020	L. reticulatus (?)	·0375
Lathyrus Aphaca	·0190	L. varius	·0200
L. Nissolia	·0120	Medicago disciformis	·0057
L. Ochrus	·1535	M. Echinus	·0235
[Lens esculentum	·0615]	M. scutellata	·0239
Lotus Tetragonolobus	·0651	M. turbinata	·0035
Lupinus angustifolius	·1074	Melilotus alba	·0025
L. Barkeri	·0342	M. dentata	·0024
L. græcus	·0220	M. gracilis	·0022
L. hirsutus	·5305	M. speciosa	·0010

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[*] A. J. Ewart, Proc. Roy. Soc. Victoria, Aug. 1908.

[†] The size of the seed is very seldom mentioned in Floras (though it might well be a useful character in diagnosis), or a wider survey of this kind would have been possible.

[Mucuna pruriens	·8370]
Ononis alopecuroides	·0084
O. biflora	·0079
Psoralea corylifolia	·0165
[Phaseolus Hernandesii	·6824
[P. vulgaris	·4105]
Scorpiurus vermiculatus	·0332
Trifolium arvense	·0022
T. incarnatum	·0047
Trifolium procumbens	·0006
T. subterraneum	·0030
Trigonella cærulea	·0026
T. cretica	·0151
T. Fœnum-græcum	·0210
[Vicia Faba (var. equina)	·5045]
[V. sativa	·0820]
[Voandzeia subterranea	·9800]

Perennial Herbs.

Astragalus Cicer	·0037
A. danicus (var. albus)	·0055
A. galegiformis	·0075
A. glycyphyllos	·0041
A. Onobrychis	·0042
Baptisia australis	·0115
B. leucantha	·0172
[Canavalia ensiformis	2·61]
Coronilla elegans	·0051
C. varia	·0050
Desmodium canadense	·0026
Galega officinalis	·0108
G. orientalis	·0054
Indigofera trifoliata	·0015
Kennedya nigricans	·0122
K. prostrata	·0260
K. rubicunda	·0248
Lotus corniculatus	·0012
L. Gebelia	·0014
L. tenuis	·0012
Lupinus affinis	·0350
Lupinus polyphyllus	·0169
Ononis antiquorum	·0031
Orobus aurantius	·0255
O. niger	·0235
O. venosus	·0165
Oxytropis campestris	·0020
O. sulphurea	·0030
Pachyrrhizus angulatus	·1690
Psoralea acaulis	·0120
Swainsona Cadelli	·0098
S. galegifolia (var. alba) (or shrub)	·0072
Tephrosia purpurea	·0117
Thermopsis alternifolia (?)	·0105
T. montana	·0148
Trifolium alpestre	·0027
T. hybridum	·0008
T. reclinatum (? annual)	·0037
T. repens	·0007
Trigonella gladiata	·0192
Vicia Cracca	·0166

Shrubs.

Abrus precatorius	·0916
Acacia armata	·0142
A. crassiuscula	·0130
A. Cyclops	·0155
A. decora	·0162
A. Drummondii	·0048
A. elongata	·0105
A. elongata (var. angustifolia)	·0124
A. hakeoides	·0345
A. leptoclada	·0178
A. linifolia	·0188
A. longifolia	·0190
A. spectabilis	·0282
A. verticillata	·0105
Acacia vestita	·0137
Astragalus chlorostachys	·0050
A. leucophyllus	·0043
Bauhinia acuminata	·3281
B. diphylla	·1904
B. Lawii	·1314
B. tomentosa	·0734
B. yunnanensis	·0883
Bossiæa scolopendria	·0155
Caragana arborescens	·0232
Carmichaelia odorata	·0023
Cassia auriculata	·0370
C. floribunda	·0188
C. tomentosa	·0090

Clianthus puniceus	·0110	Hovea longifolia (var. normalis).	·0408
Clitorea Ternatea	·0535	Indigofera arrecta	·0040
Colutea arborescens	·0150	I. galegoides	·0059
C. cruenta	·0252	I. tinctoria	·0033
Crotalaria juncea	·0439	Kennedya retusa	·0423
C. retusa	·0180	Lupinus arboreus	·0302
C. striata	·0049	L. Douglasii	·0187
Cytisus elongatus	·0056	Mimosa pudica	·0052
C. hirsutus	·0070	Ononis arvensis	·0060
C. purpureus	·0080	O. fruticosa	·0110
C. sessiliflorus	·0172	O. hircina	·0067
C. scoparius	·0095	O. porrigens (?)	·0062
Dorycnium hirsutum	·0064	O. rotundifolia	·0055
D. suffruticosum	.0022	O. spinosa	·0060
Genista hispanica	·0052	Oxylobium cordifolium	·0025
G. radiata	·0086	Petalostylis labicheoides	·0130
G. sagittalis	·0044	Pultenæa retusa	·0017
G. tinctoria	·0021	Sesbania aculeata	·0833
G. virgata	·0074	S. ægyptiaca	·0142
Gompholobium latifolium	·0052	Spartium junceum	·0129
Goodia lotifolia	·0169	Sphærolobium vimineum	·0010
Hardenbergia Comptoniana	·0327	Ulex europæus	·0057
H. monophylla	·0240	Viminaria denudata	·0063

Shrubs or Small Trees.

Acacia arabica	·1375	Bauhinia racemosa	·1995
A. cæsia	·1925	Cæsalpinia pulcherrima	·1793
A. Farnesiana	·0601	Caragana tragacanthoides	·0260
A. neriifolia	·0250	Carmichaelia australis	·0055
A. Riceana	·0135	Erythrina Vespertilio	·1547
A. rostellifera	·0110	Jacksonia scoparia	·0035
Albizzia lophantha	·1112	Parkinsonia aculeata	·0818
Bauhinia monandra (?)	·1770	Pithecolobium Unguis-cati	·1208

Trees.

Acacia dealbata	·0212	Bauhinia Hookeri	·3052
A. Gnidium (var. latifolia)	·0050	B. purpurea	·4210
A. leucophlæa	·0420	B. variegata (alba)	·4385
A. penninervis	·0575	Butea frondosa	·8800
A. retinodes	·0135	Cassia brasiliana	·0307
A. stenophylla	·0510	C. Fistula	·2133
Acrocarpus fraxinifolius	·0297	C. glauca	·0305
Adenanthera pavonina	·2912	C. siamea	·0328
Albizzia Lebbek	·1412	Castanospermum australe	22·7
A. moluccana	·0155	Ceratonia siliqua	·1890
A. procera	·0600	Colvillea racemosa	·4030
Barklya syringifolia	·1370	Erythrina indica	·5258

Hymenæa Courbaril	·9974	Pithecolobium Saman	·2423
Laburnum alpinum	·0290	Poinciana elata	·1500
L. vulgare	·0318	P. regia	·6024
Leucæna glauca	·0400	Pongamia glabra	1·7596
Mimosa rubicaulis	·0302	Saraca cauliflora	5950
Parkia biglandulosa	·3144	Sophora tetraptera	·0617
Peltophorum ferrugineum	·0755	Tamarindus indica	1·0960
Pithecolobium dulce	·1658	Trachylobium Hornemanniaum	1·0510

The results of this examination are as follows:—

Annual Herbs.

45 species together weigh	5·1819 g.
7 species in brackets	3·5579
38 remaining species	1·6240
Average weight	0·0427

Perennial Herbs.

41 species together weigh	3·1651 g.
1 species in brackets	2·61
40 remaining species	0·5551
Average weight	0·0139

Shrubs.

74 species together weigh	1·9137 g.
Average weight	0·0259

Shrubs or Small Trees.

16 species together weigh	1·4989 g.
Average weight	0·0937

Trees.

40 species together weigh	34·2767 g.
Average weight	0·8569

It is at once seen that the order of magnitude of the average weight of the seed from the tree species is considerably higher than that for the other classes of habit *. The herbaceous species and shrubs form a group with comparatively small seeds *. The small class of "shrubs or small trees" shows a distinct upward tendency in the size of seed. There is a great gap in size between this class, however, and the true trees. The most noticeable feature of this correlation is the uniformity of each class. Out of 78 (uncultivated) herbaceous species only 11 have seeds more than 0·03 g. in weight; the 40 perennials only having one of these, this and seven of the other ten annuals being species of *Lupinus*. Also only 14 of the 74 shrubs had seeds weighing more than 0·03 g. In the two other classes of habit the statistics are quite different. Of the 16 "shrubs or small trees" 10 had seeds weighing more than 0·03 g., 8 being more than 0·1 g. Of the 40 species of trees no fewer than 34 surpassed 0·03 g., and 22 of these weighed more than 0·1 g.

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* The conspicuous excess in the average for trees is partly due to the enormous size of the seeds of *Castanospermum australe*: if we omit this species, however, the average becomes 0·2986, *i. e.* still much higher than that of other classes.

Moreover, within single genera indications of the same kind are not wanting. The genera *Acacia* and *Bauhinia*, for instance, comprise shrubs, shrubs or small trees, and trees. In *Acacia* 14 species of shrubs give an average weight of 0·0163, 12 species of the other two classes give 0·0525. In *Bauhinia* the average for five shrubs is 0·162, for five species of trees and "shrubs or small trees" the average is 0·308.

It thus appears that the production of large seeds is definitely correlated with the tree-habit. What may be the nature of this correlation it is hard to say. To produce a large seed may be a symptom of the greater vigour of growth that distinguishes trees from shrubs. (It is difficult to institute a comparison in this respect between woody and herbaceous plants.) Or, on the other hand, the large seed may be rendered necessary by the advisability of producing a large seedling which will give the tree a good start in life. It must be borne in mind that on the whole trees seem to produce, relatively to bulk, much fewer seeds than herbaceous plants in the same period of time: what is lost in number is balanced by the superior equipment with reserves of each individual embryo. It appears that a tree devotes itself to the production of few offspring, each well furnished with the means of support; while the more opportunist herb produces an enormous number of offspring, among which there must be a very high mortality.

We have seen that the characters of tetrarchy and a low transition are correlated with massiveness of the seedling; and also that these same characters are largely correlated with the tree-habit. It is now clear that the reason why both of these correlations can exist simultaneously is that, whatever may be its significance, there is a deeper correlation between the tree-habit and the production of large seeds and seedlings.

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* The large seeds of the Phaseoleæ and certain *Lupinus* spp. are noteworthy exceptions. If we omit *Lupinus hirsutus*, for instance, the average for annual herbs is reduced to 0·0293.

THE PRIMITIVE HABIT.

There is a strong probability that among Angiosperms generally the arboreal habit is primitive, the herbaceous habit derived. The well-nigh universal prevalence of the arboreal type among Gymnosperms, Pteridospermæ, Cordaitales, and the more primitive Pteridophyta leaves little room for doubt as to the truth of this view: especially as the various groups of Archichlamydeæ which have been regarded as primitive ("Amentiferæ," Ranales, and so on) consist largely of woody forms.

There is much to indicate that the arboreal habit is primitive in the Leguminosæ also. The closely related and probably relatively primitive Connaraceæ and Rosaceæ consist almost wholly of woody species, and so do those Leguminosæ to which they are most closely allied, viz. Mimosoideæ and Cæsalpinioideæ. The Sophoreæ and Podalyrieæ, which are by some regarded as the most primitive tribes of the Leguminosæ, are almost entirely arboreal, and so are the nearly-related Genisteæ. The more advanced tribes of the order contain a high proportion of herbaceous forms.

Thus the theory that the arboreal habit is primitive, the herbaceous derived, within the Leguminosæ, seems to be well founded; just as for the Angiosperms generally.

This being so, it follows from the results of the last section that large seeds and seedlings are probably primitive, small seeds and seedlings derived. Thus we again reach the conclusion that the stable form of tetrarchy and the low transition typical of large seedlings are the fundamental characters within the order, from which the other types of structure have been evolved. The whole series of correlations and tendencies within the Leguminosæ appears so consistent that there is much probability that the interpretations which have been placed upon them are substantially correct.

SUMMARY AND CONCLUSIONS.

In the present paper the seedling structure of a considerable number of species of the Leguminosæ has been placed on record; the species examined belong to most of the tribes of the three sub-orders, and may be considered representative of the family as a whole. Detailed information as to individual species is given in Part A. In Part B is given a Summary List of the most important features of form, size, and structure exhibited by the seedlings of the Leguminosæ, so far as is at present known to the author: here is placed also a concise *résumé* of the characteristics of individual tribes and sub-orders In Part C the information is analysed, and various new facts are introduced as they bear upon the discussion.

The following are in brief the main conclusions attained from this study:—

(i.) The stable tetrarch type of symmetry is found typically in seedlings of large size.

(ii.) The production of large seeds and seedlings is correlated with the tree-habit.

(iii.) The arboreal habit is in all probability primitive in the Leguminosæ, as in Angiosperms generally, the herbaceous habit derived.

(iv.) The stable type of tetrarchy is therefore probably fundamental and primitive for the whole family.

(v.) Reduction in the size of the seedling has given rise to an unstable type of tetrarchy, in which the intercotyledonary xylems, though cotyledonary in nature, stand in an intimate supplementary relation to the early plumular traces.

(vi.) Triarchy and diarchy are closely associated with this unstable form of tetrarchy. The whole group of types of symmetry is in a highly variable condition, all three forms co-existing within single tribes, genera, species, and even individuals.

(vii.) Diarchy is the final term in this reduction-series; and when attained it is often extremely stable.

(viii.) The whole series given above applies mainly to epigeal types. In cases of hypogeal germination, in which the plumule develops fast, the epicotyledonary traces may be directly represented by primary xylem in the root.

(ix.) In particular the hypogeal Vicieæ exhibit a very constant triarch structure, in which two xylems are cotyledonary, the third plumular. This type has no connection with the epigeal form of triarchy.

(x.) Other types of structure found in the family are also derivable from the stable form of tetrarchy.

(xi.) The anatomical transitions from root- to stem-structure are classified into three main and two subsidiary grades according to the level at which they take place. Low transitions are characteristic of massive, high transitions of slender, hypocotyls; while intermediate transitions are found in hypocotyls of intermediate diameter.

(xii.) The diameter of the axis is the most important factor in determining the level of transition: length of hypocotyl has a subordinate, and largely psychological, effect.

(xiii.) Since both the type of symmetry and the level of transition are so closely related to the size of the seedling, it appears that these anatomical characters are not likely to be of more value in solving phylogenetic problems than the size-characters themselves.

(xiv.) Within narrowly restricted groups, however, it seems that a type of symmetry, or a certain arrangement of bundles or vascular elements, or even in isolated instances a tendency towards a particular level of transition, may be preserved hereditarily in spite of cenogenetic influences. To a limited extent, therefore, characters of seedling structure may be of diagnostic value; but it is exceedingly risky to apply them to solve the broader problems of phylogeny.

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EXPLANATION OF THE PLATES.

In the following diagrams protoxylem is indicated by solid black; metaxylem by line shading; phloem simply outlined; the endodermis is represented sometimes by a broken, sometimes by a continuous line; the epidermis by a continuous line; lines of split are in some cases indicated by dotted lines. No ambiguity should arise in the use of these symbols, which usually explain themselves or are elucidated in the text. Further signs are mentioned when they occur.

px. = protoxylem.
mx. = metaxylem.
x_2. = secondary xylem.
ph. = phloem.
p.f. = pericycle fibres.
cor. = cortex.
p. = pith.
sec. = secretory cell.
ep. = epidermis.
l.t. = leaf trace (i. first leaf; ii. second leaf).
f.r. = faisceau réparateur.

The drawings in which individual cells are shown were made with the aid of a camera lucida (Pl. **8**. fig. 109 only excepted).

PLATE **1**.

(*Seedlings.*)

Fig. 1. *Medicago lupulina.*
2. *Melitotus arvensis.*
3. *Trigonella cretica.*
4. *Onobrychis sativa.*
5. *Caragana arborescens.*
6. *Ervum Lens.*
7. *Phaseolus vulgaris.*
8. *Vicia sativa.*
9. *Vicia Faba.*

Fig. 10. *Pisum sativum.*
11. *Scorpiurus vermiculatus.*
12. *Anthyllis Vulneraria.*
13. *Lathyrus Nissolia.*
14. *Colutea arborescens.*
15. *Trifolium arvense.*
16. *Ulex europæus.*
17. *Lotus corniculatus.*

Figs. 1–5 and 14–17 are ½ natural size (linear); 6–10 are ¼ natural size; 11–13 are ⅓ natural size.

PLATE **2**.

Figs. 18–23. *Acacia doratoxylon.* 18, root; 19, 5 mm. below collet; 20, collet; 21, half-way up hypocotyl; 22, 2 mm. below node; 23, base of cotyledon.

24. *Albizzia moluccana.* T.S., cortex, half-way up hypocotyl, showing the zone of thick-walled small cells.

25–28. *Pithecolobium Saman.* 25, root; 26, 3 mm. below collet; 27, half-way up hypocotyl; 28, 2 mm. below node.

29–33. *Pithecolobium Unguis-cati.* 29, root; 30, 5 mm. below node; 31, 3 mm. below node; 32, 1 mm. below node; 33, first intercotyledonary internode.

34–37. *Adenanthera pavonina.* 34, root; 35, 5 mm. below collet; 36, 4 mm. above collet; 37, 3 mm. below node.

46–50. *Cassia lævigata.* 46, root; 47, collet; 48, quarter up hypocotyl; 49, 2 mm. below node; 50, base of cotyledon.

PLATE 3.

Figs. 38–41. *Bauhinia racemosa.* 38–40, a hexarch seedling: 38, 1·5 mm. below collet; 39, collet; 40, half-way up hypocotyl: 41, a tetrarch seedling, 1 mm. below collet. See text.

42–45. *Bauhinia tomentosa.* 42, root; 43, collet; 44, quarter up hypocotyl; 45, 1 mm. below node.

51, 52. *Guilandina Bonducella.* 51, 5 mm. below node; 52, 2 mm. below node.

53. *Cæsalpinia sepiaria.* T.S. of the bundle which enters the plumule from the root, at base of first epicotyledonary internode.

54. *Cæsalpinia sepiaria.* 10 mm. below node; showing one bundle in the triad position before the others.

55–60. *Sophora tetraptera.* 55, 12 mm. below node; 56, 8 mm. below node; 57, 4 mm. below node; 58, 2 mm. below node; 59, just above node; 60, half-way up first epicotyledonary interdode.

PLATE 4.

Figs. 61–68. PODALYRIEÆ. 61, 68, *Thermopsis montana, Baptisia leucantha*; 62, 63, 64, 65, 67, *Viminaria denudata*; 62, 63, 66, 68, *Pultenæa daphnoides, Chorizema cordatum.* Diagrams representing the variations and relationships of structure within the tribe. See text. (The groups of dots represent secondary plumular traces.)

69–71. *Spartium junceum.* 69, root; 70, half-way up hypocotyl; 71, base of cotyledon (dorsal surface upwards).

72. *Crotalaria retusa.* Collet region.

PLATE 5.

Figs. 73, 74. *Crotalaria incana.* 73, quarter up hypocotyl; 74, base of cotyledon (the epidermis is that of the ventral surface).

75. *Cytisus canariensis.* Root.

76, 77. *Ononis rotundifolia.* 76, root; 77, 4 mm. below node.

78. *Trigonella gladiata.* 5 mm. below node.

79–81. *Medicago lupulina.* 79, root; 80, collet; 81, just above collet.

82–84. *Melilotus arvensis.* 82, root; 83, quarter up hypocotyl; 84, half-way up hypocotyl.

PLATE 6.

Fig. 85. *Melilotus arvensis.* Three-quarters up hypocotyl. (Dotted lines = cambium.)

86. *Anthyllis tetraphylla.* Three-quarters up hypocotyl.

Figs. 87–89. *Dorycnium hirsutum.* Triarch seedling. 87, root; 88, two-thirds up hypocotyl; 89, 3 mm. below node.

90. *Caragana arborescens.* Triarch seedling. 90, collet. (See Pl. 7.)

93. *Swainsona Cadelli.* Half-way up hypocotyl.

PLATE 7.

Figs. 91, 92. *Caragana arborescens.* 91, half-way up hypocotyl; 92, 3 mm. below node (the brackets indicating the three original xylems and the small new fourth group).

PLATE 8.

Figs. 94, 95. *Scorpiurus sulcata.* 94, just below collet; 95, just above collet.

96, 97. *Hedysarum coronarium.* 96, half-way up hypocotyl; 97, cotyledon tube and first leaf.

105. *Pisum sativum.* T.S. of the central cylinder of the axis at the departure of the first bract-like leaf. (*Cf.* Pl. 9. fig. 104.) Shows (from above downwards) the median bundle of the second leaf, the "medullary xylem" formed by the fusion of two lateral "faisceaux réparateurs," and the other two lateral bundles which have separated, leaving a pith between; also the gap in the endodermis through which the first median leaf-trace has passed out.

106–108. *Vicia Faba.* Diagrams illustrating the behaviour of the vascular strands in: fig. 106, tetrarch; 107, pentarch; and 108, hexarch seedlings. For explanation, see text, p. 57.

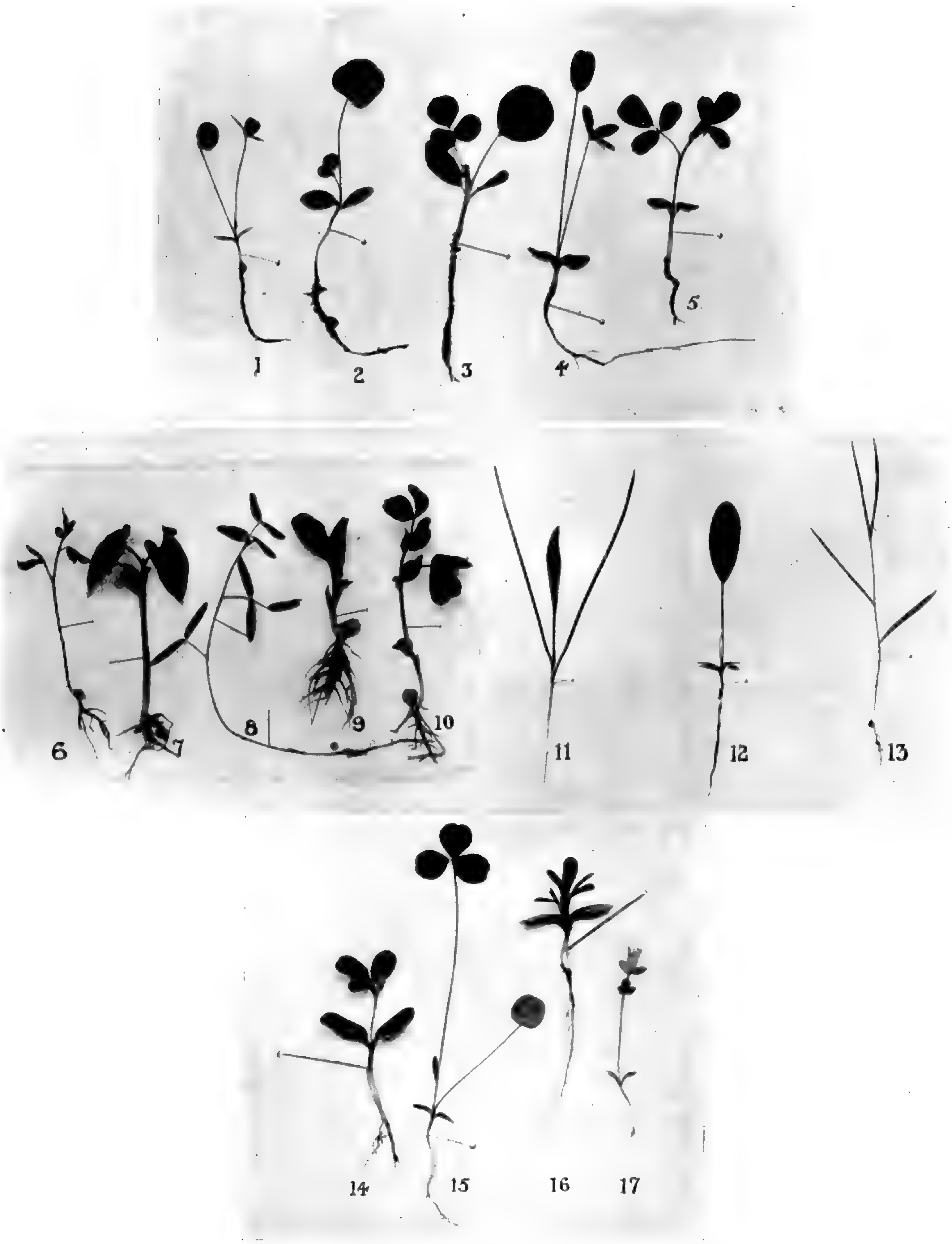
109. *Phaseolus Hernandesii.* T.S. of the median bundle of a primordial leaf in the base of the first epicotyledonary internode; showing double structure of the xylem.

110, 111. *Voandzeia subterranea.* 110 & 111 show the fate of the five xylem strands in a pentarch seedling.

PLATE 9.

Figs. 98–104. *Pisum sativum.* Diagrams representing the course of the vascular strands in a series of transverse sections. The conventions and letters used are somewhat different to those in other diagrams; for explanation, see text, p. 55.

Botany School, Cambridge,
August 1911.



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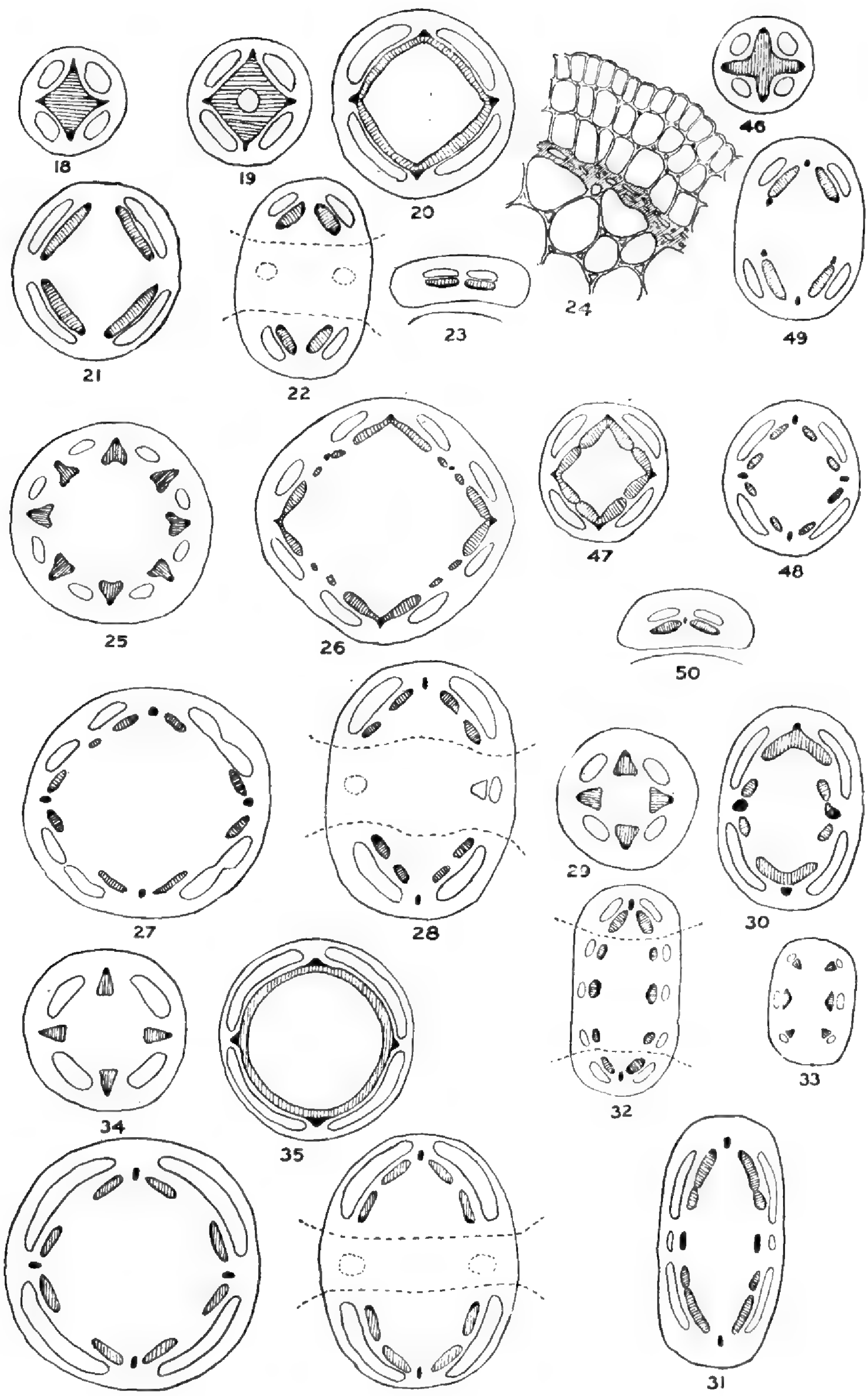

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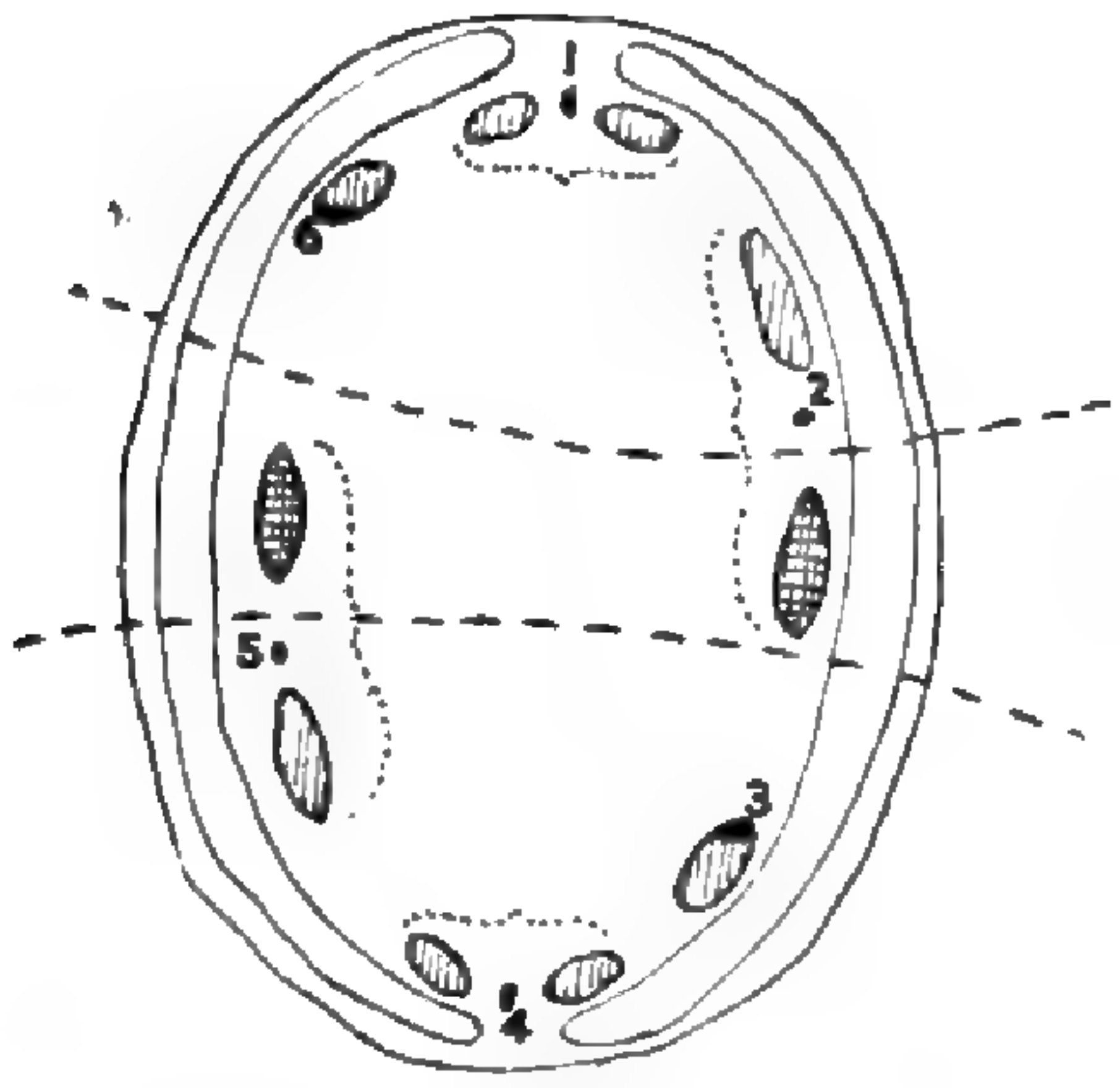

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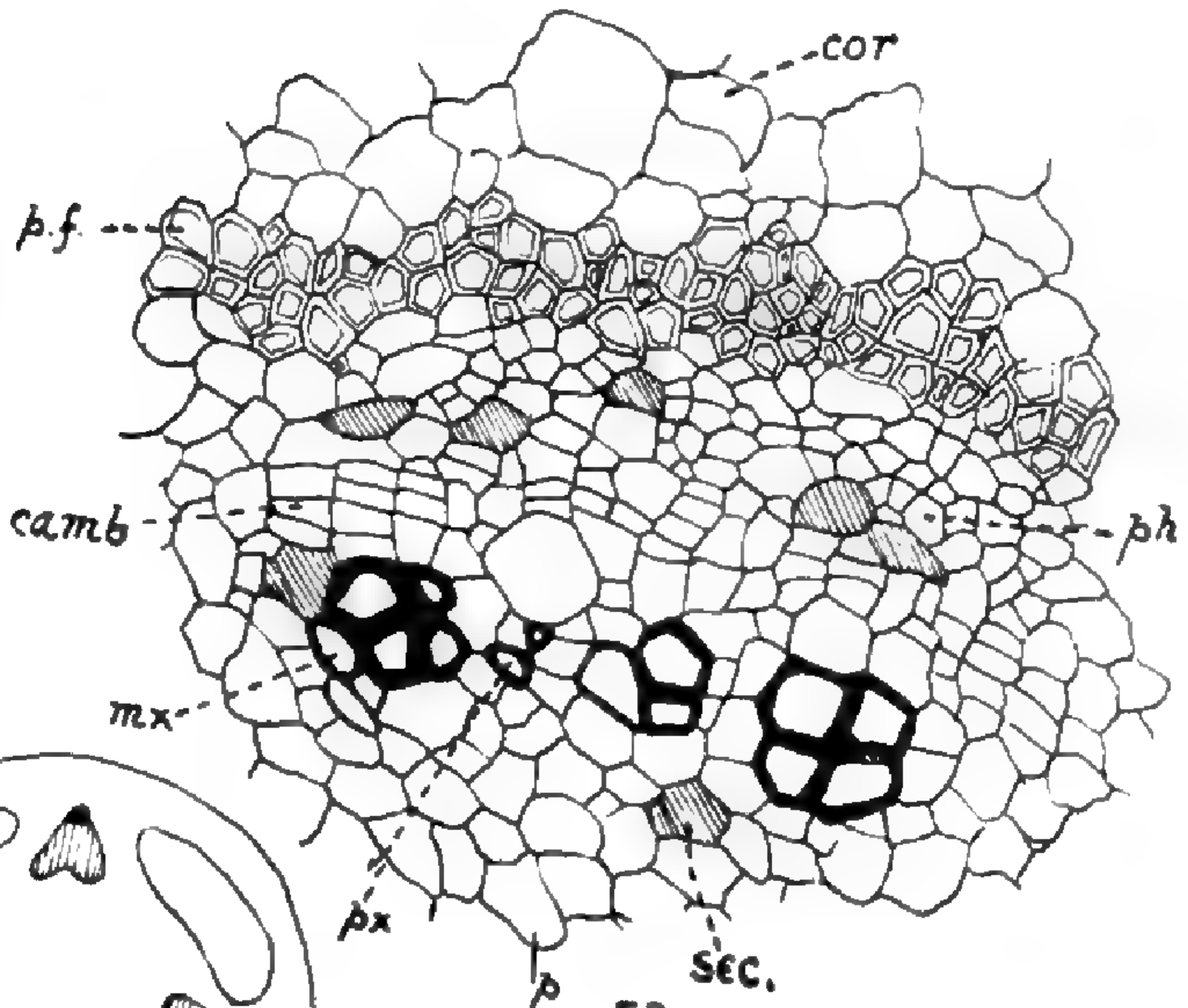

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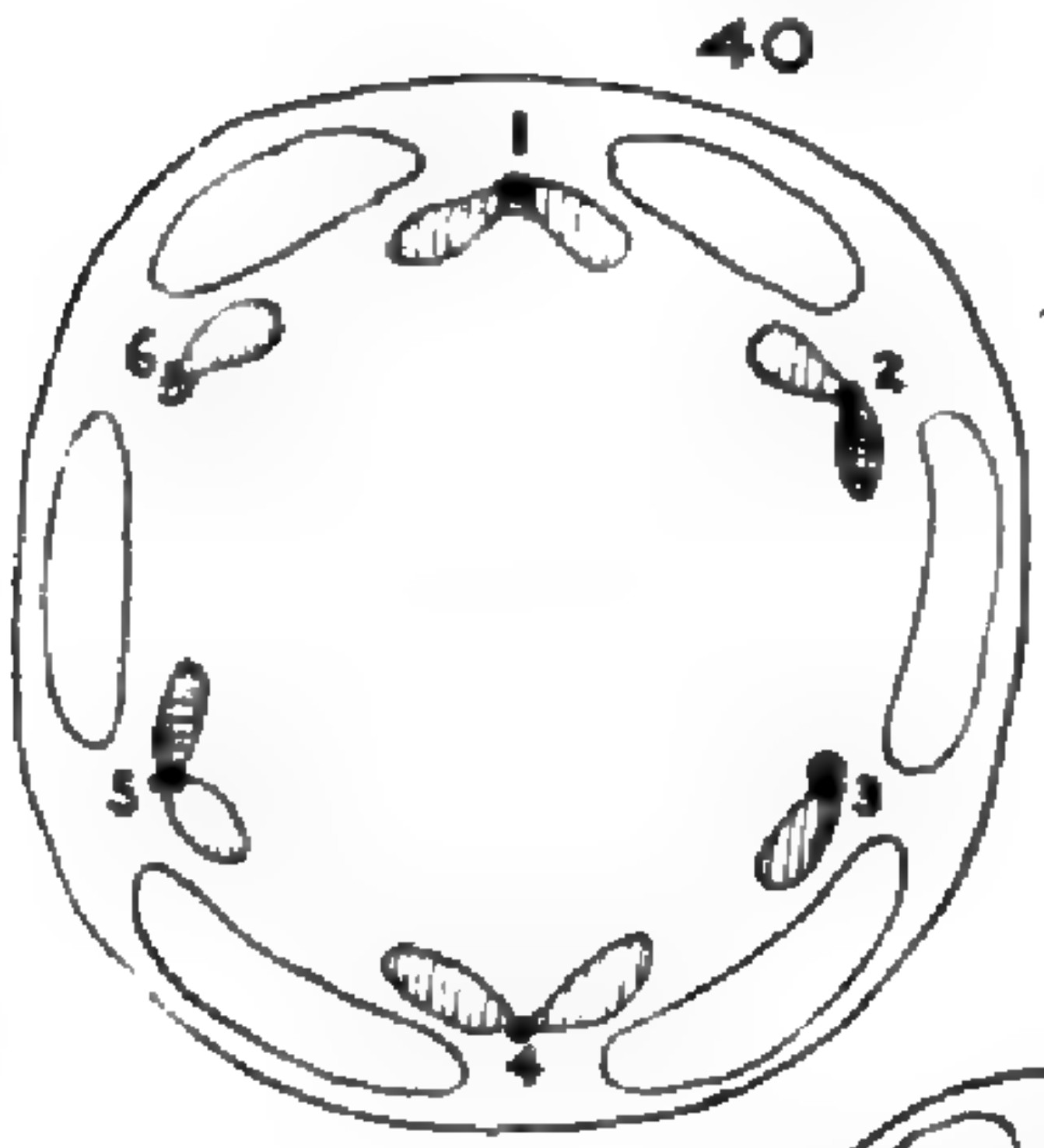

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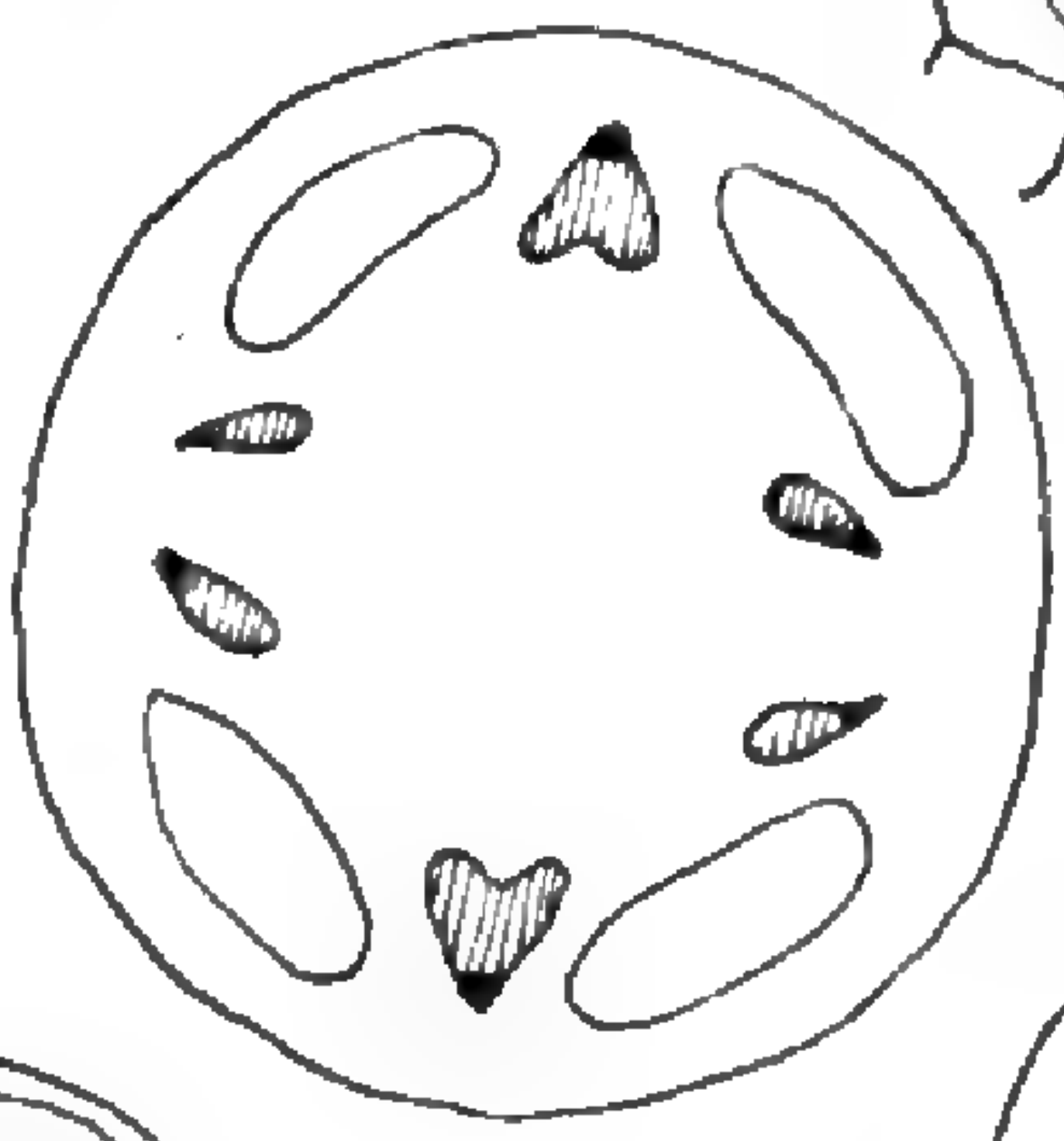

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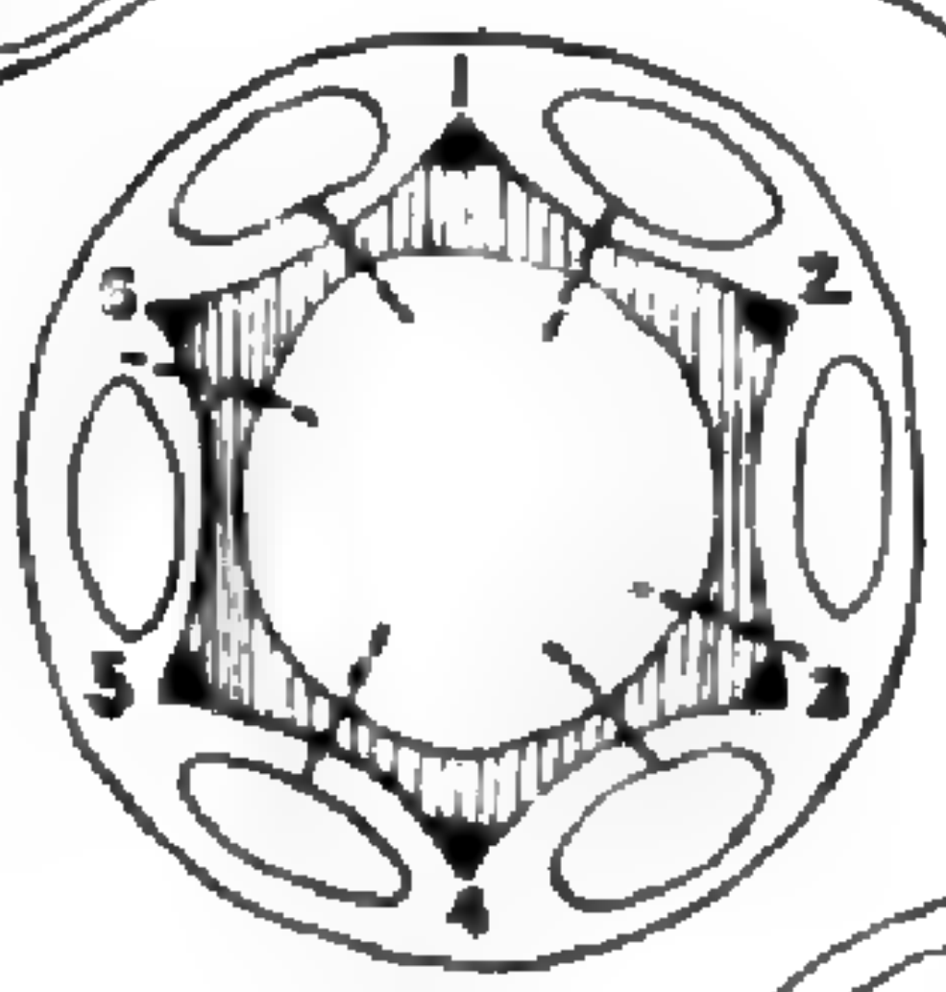

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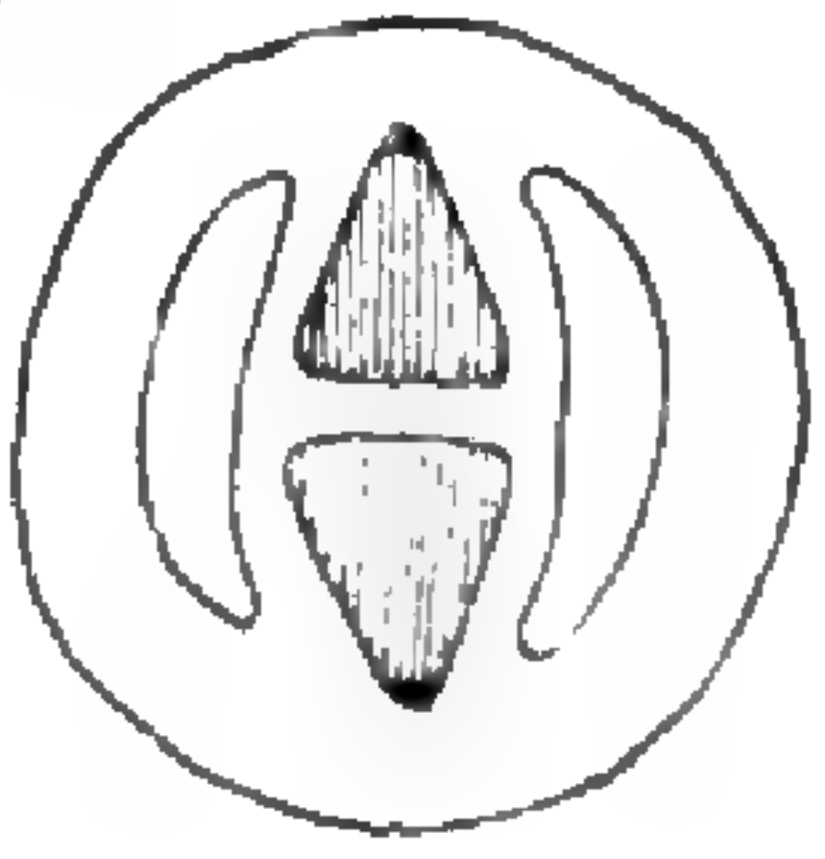

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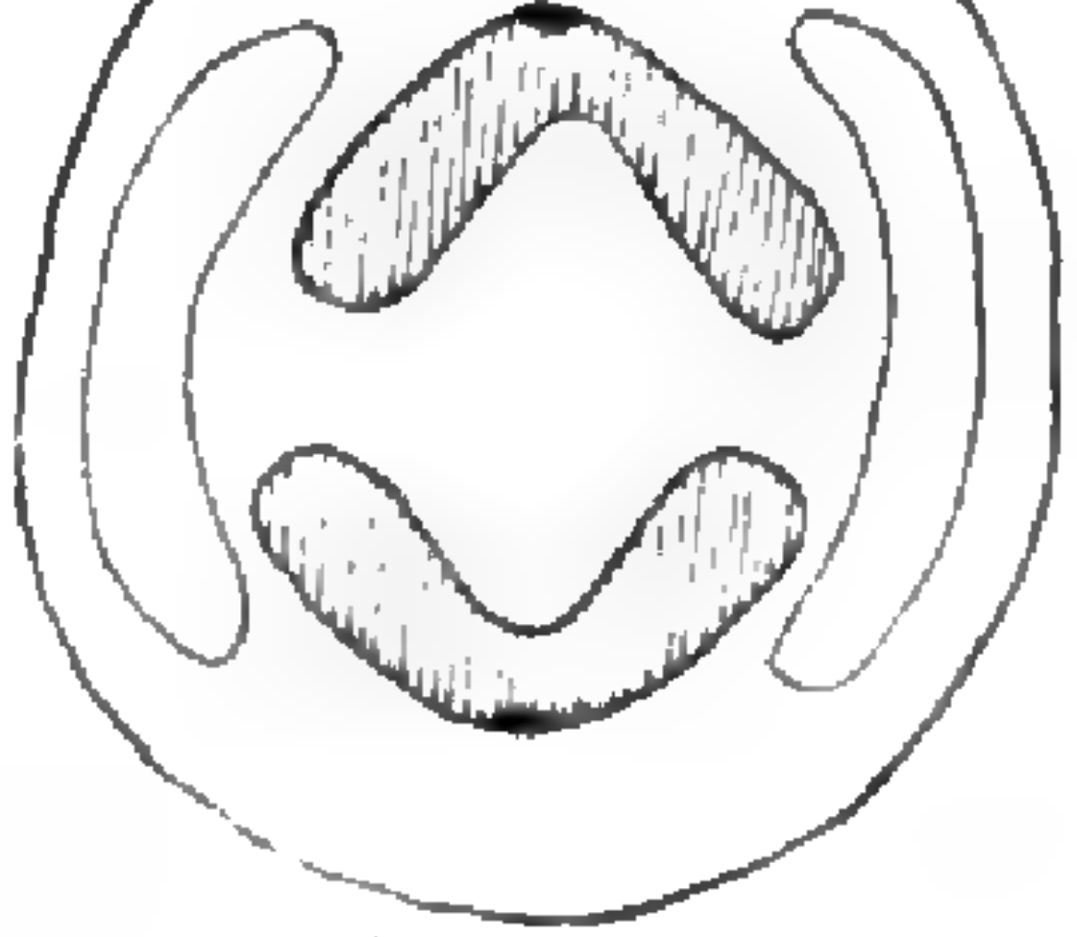

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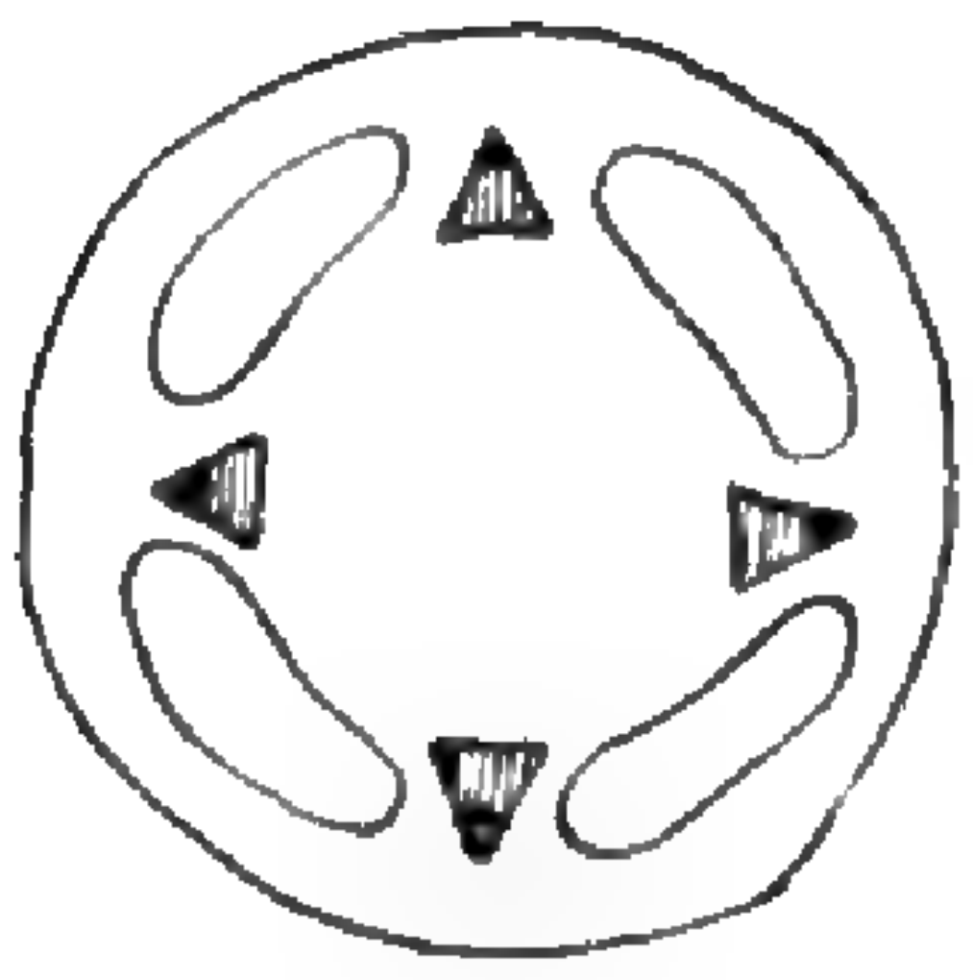

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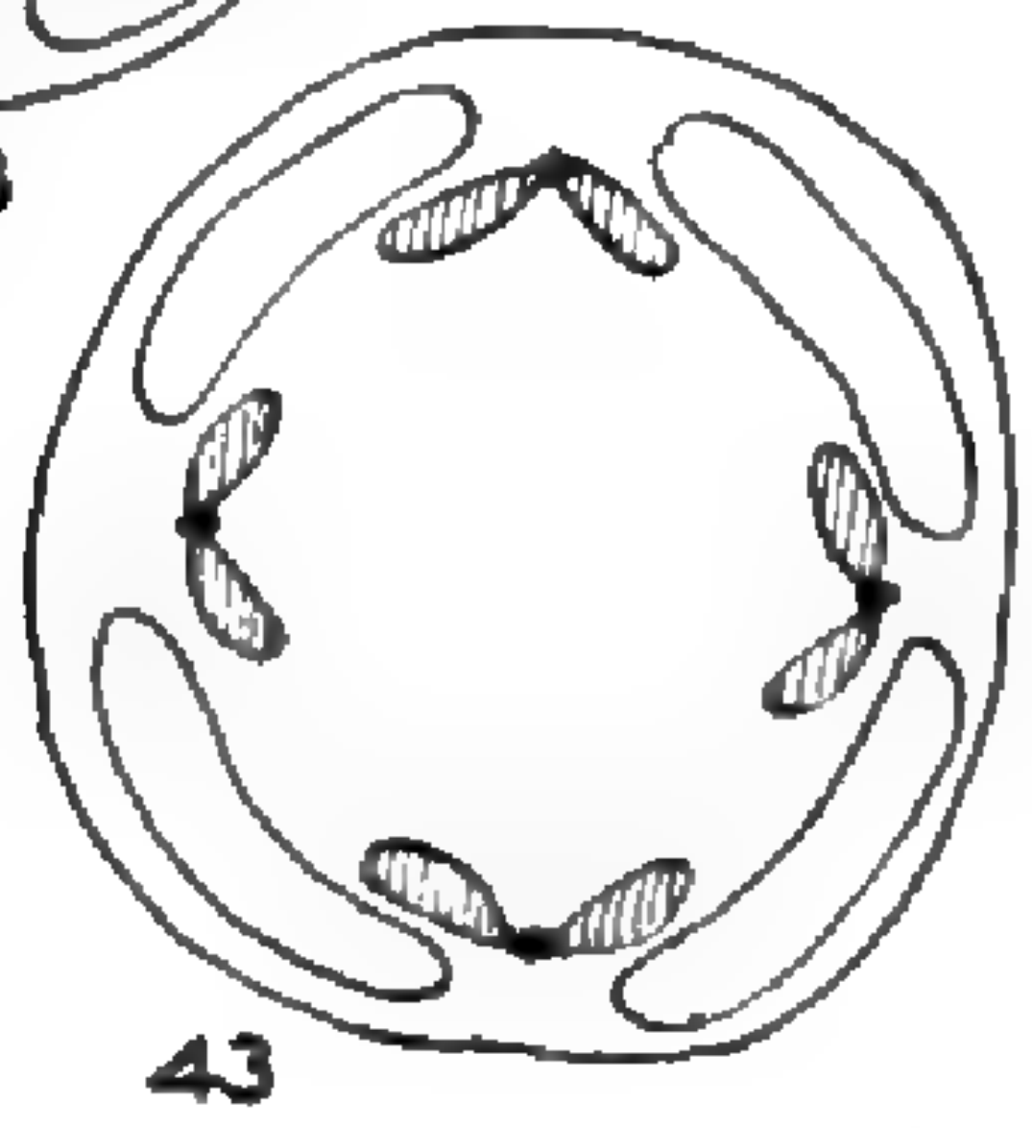

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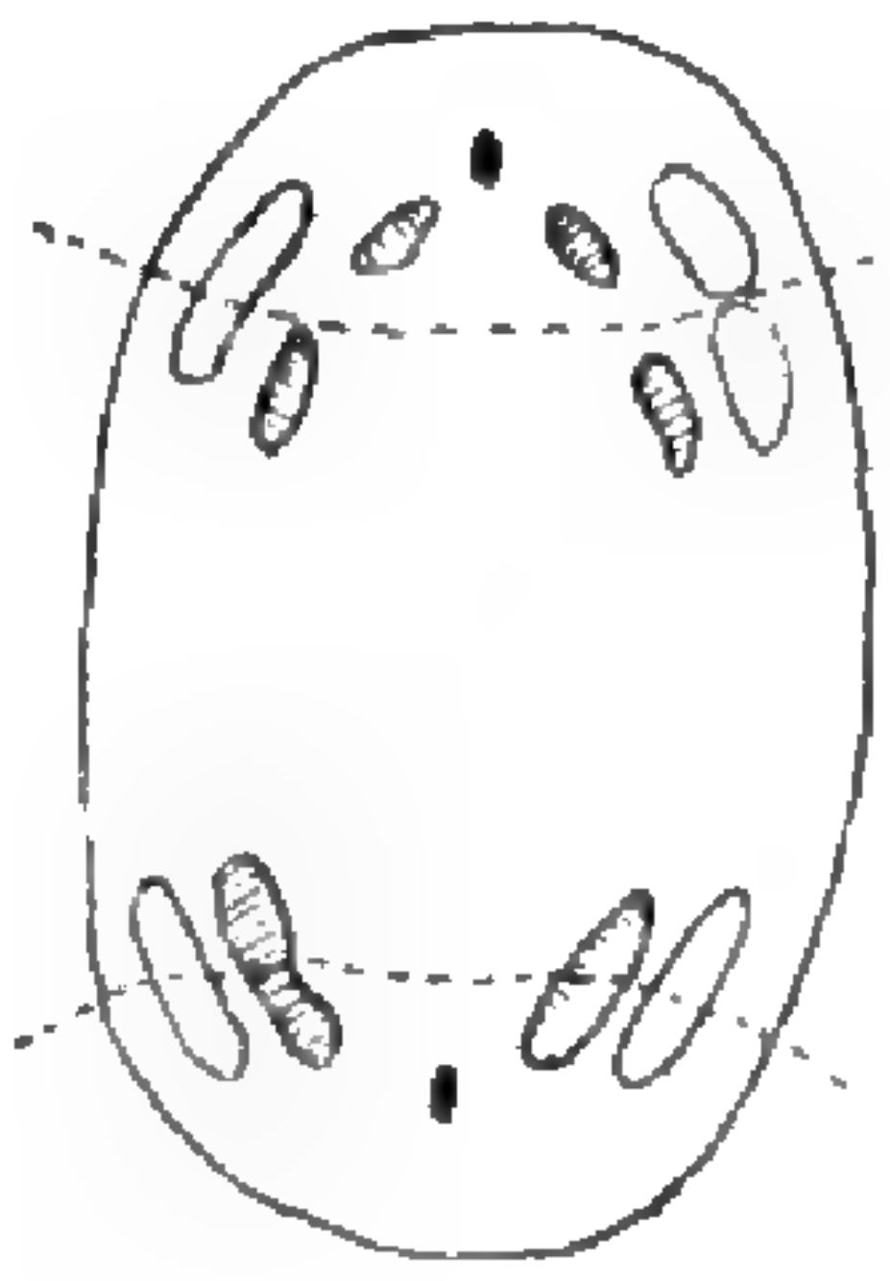

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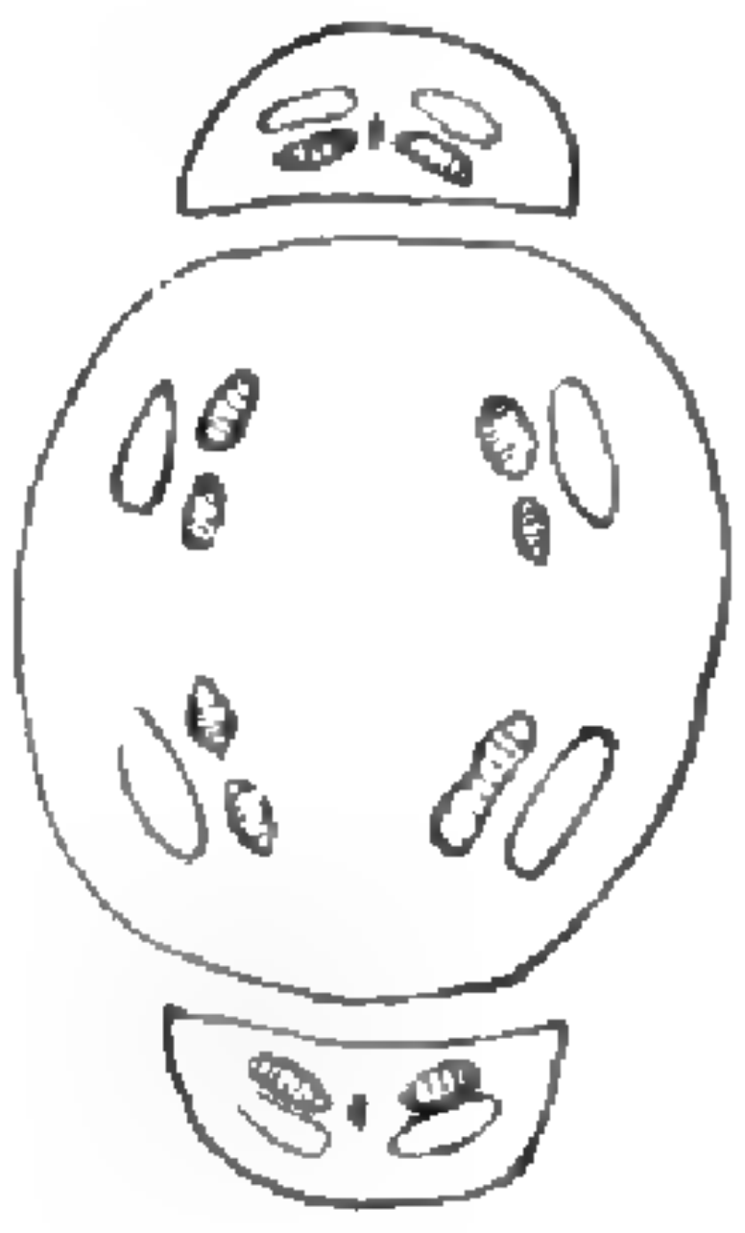

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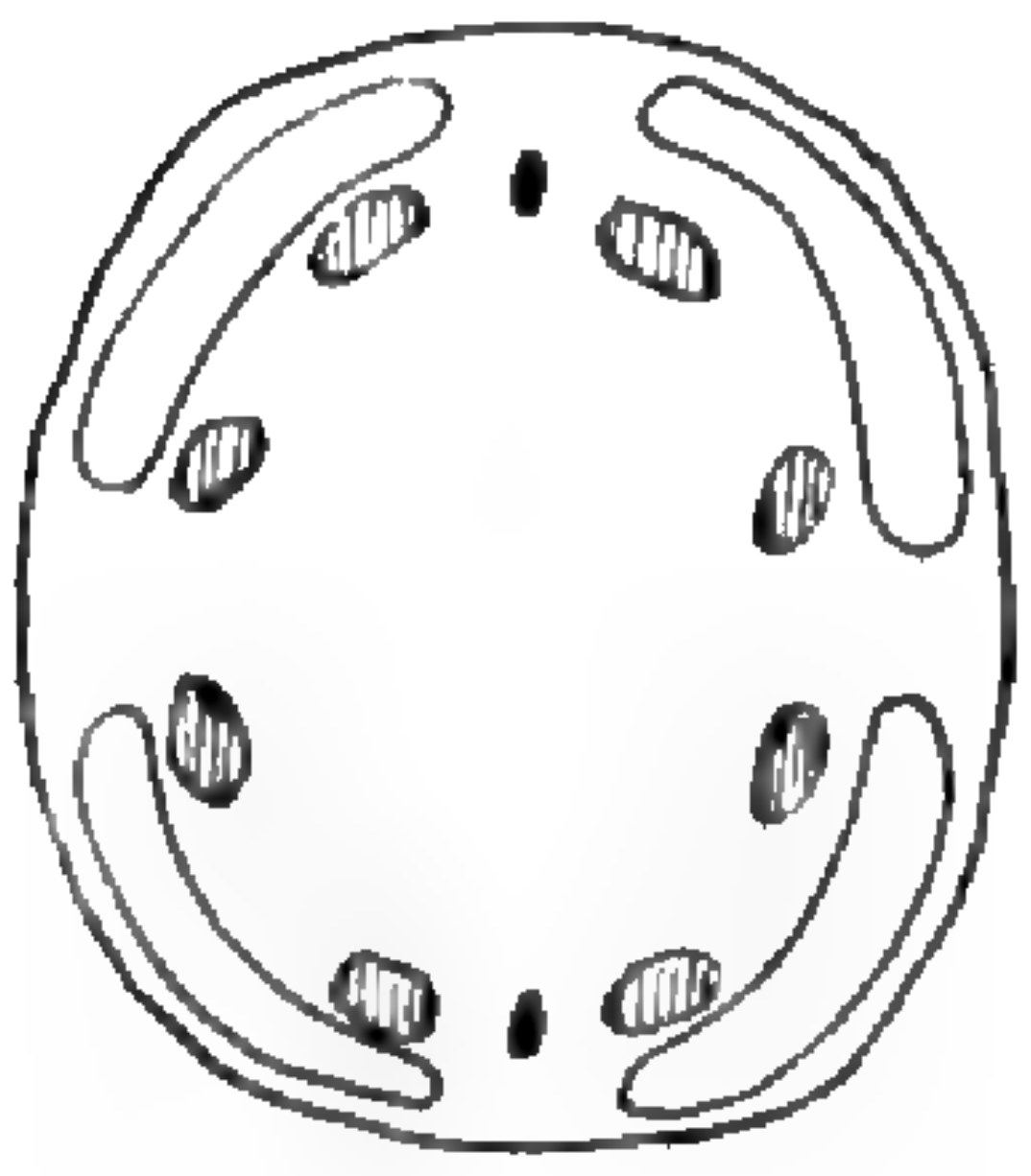

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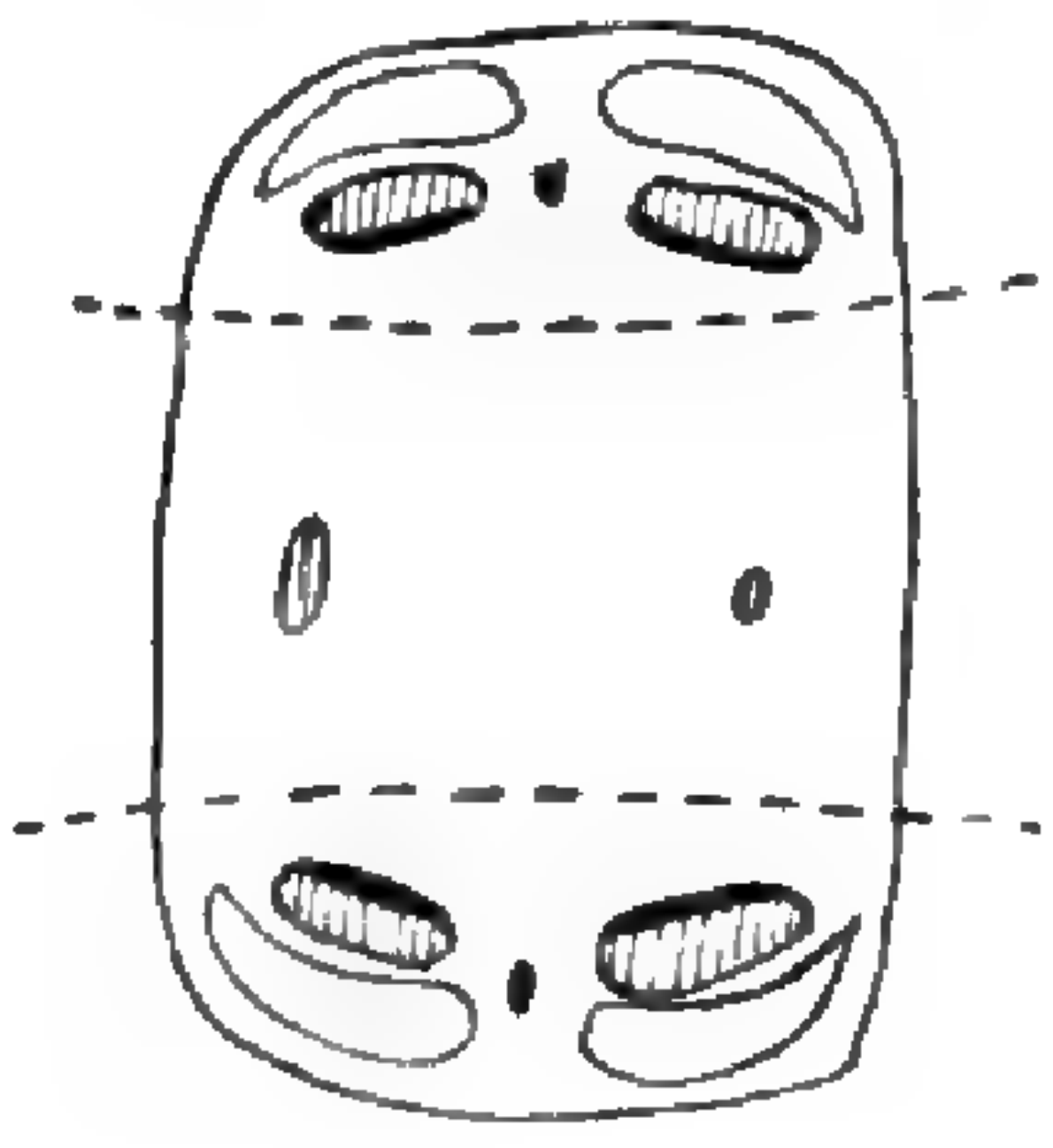

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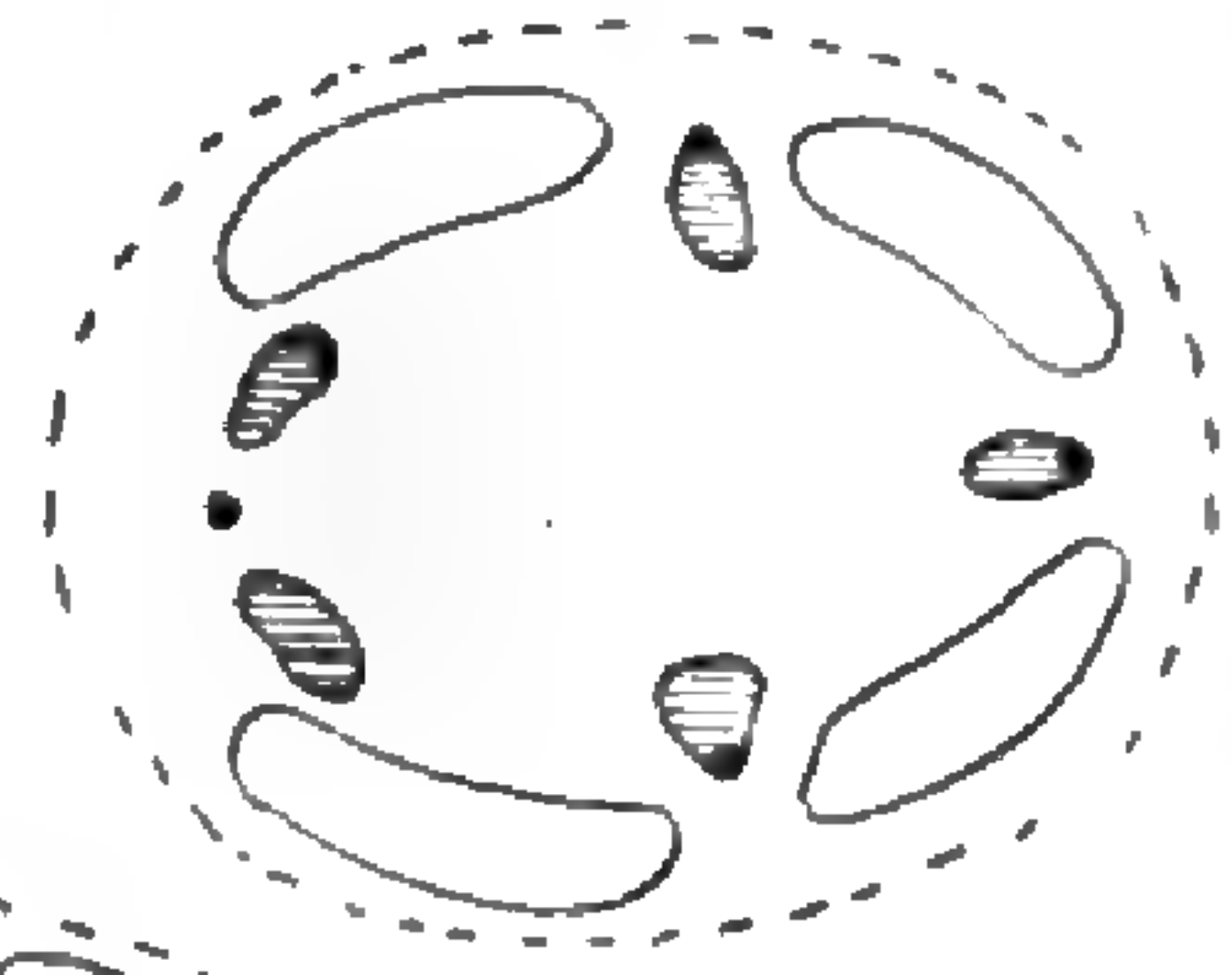

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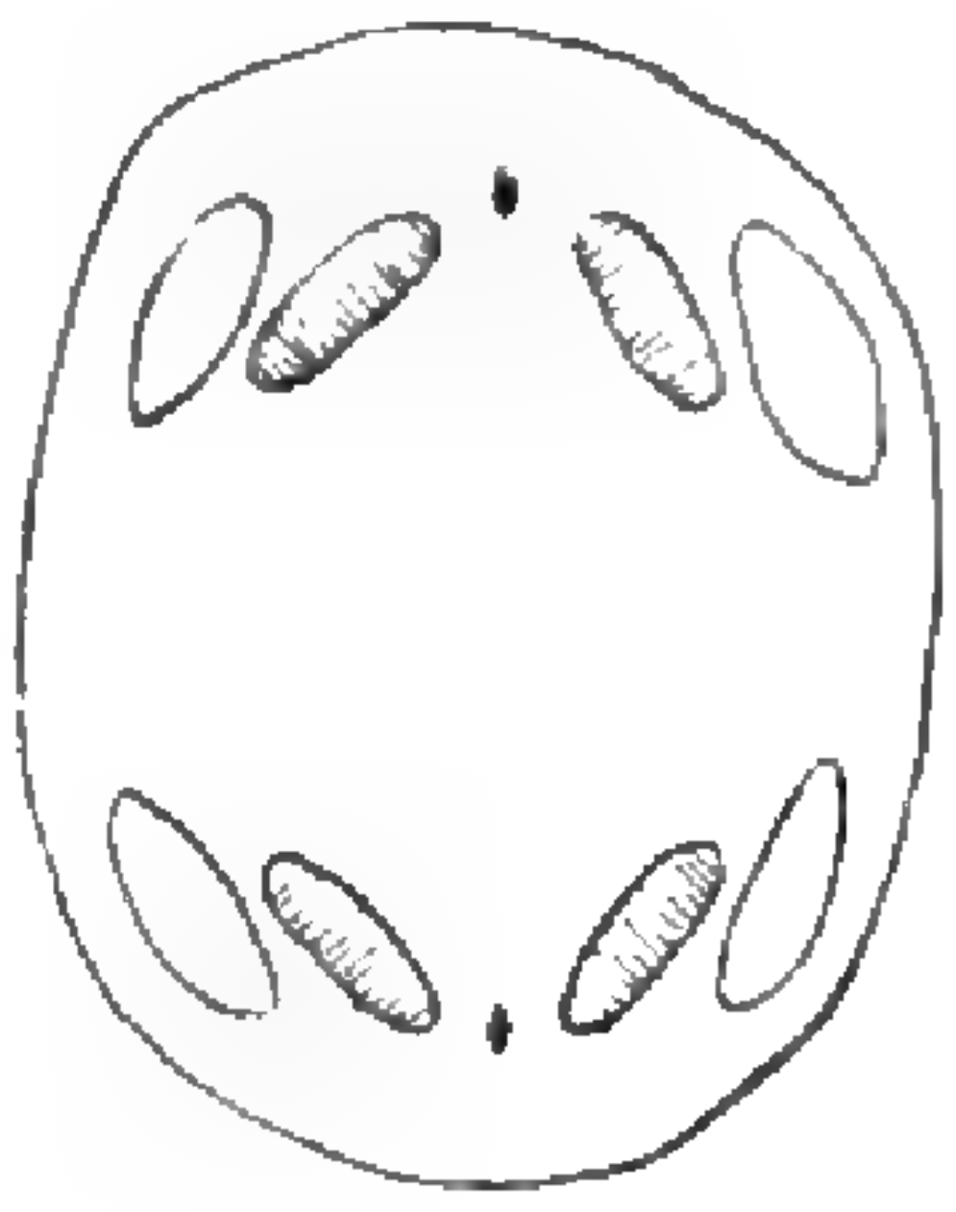

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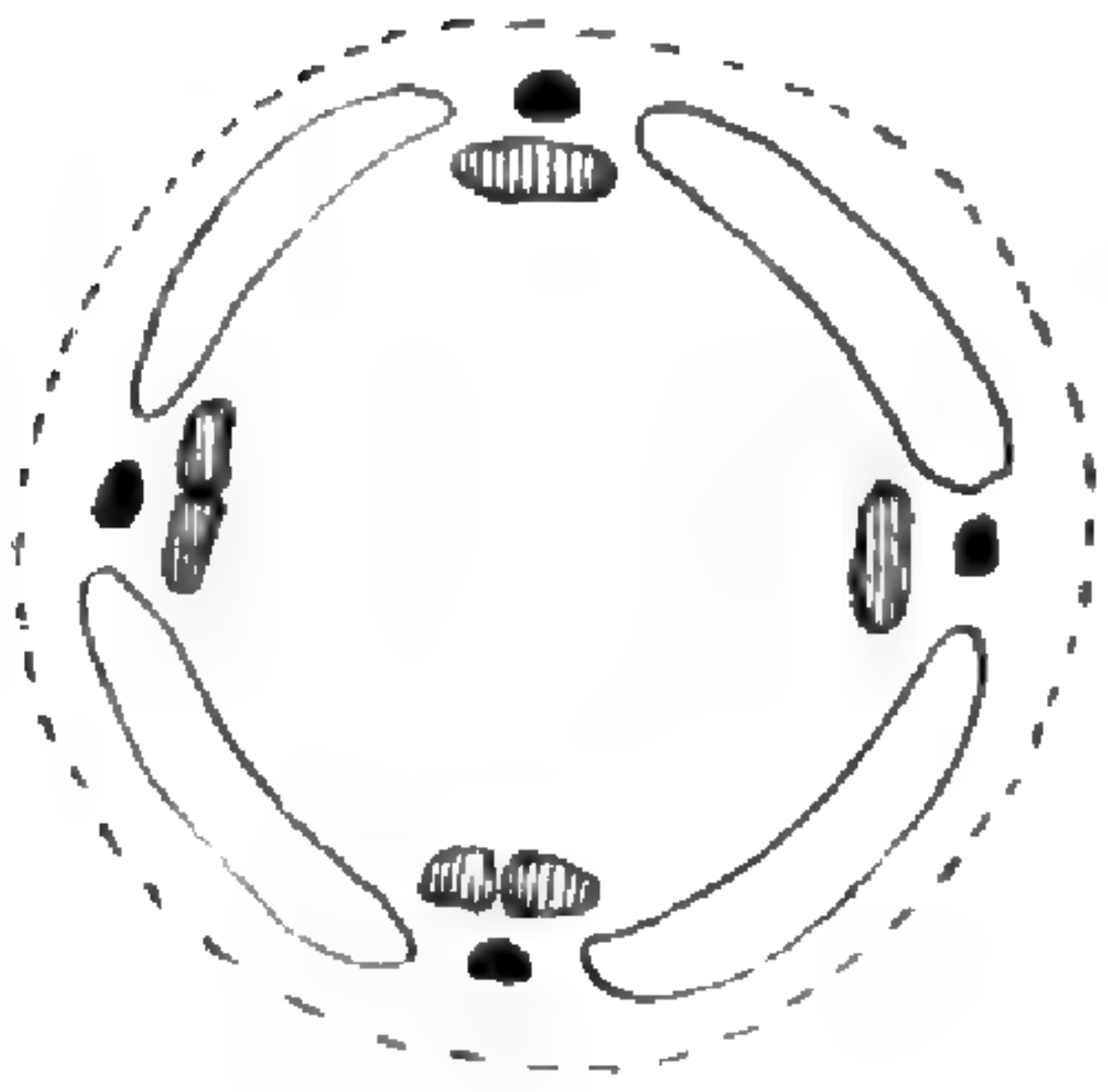

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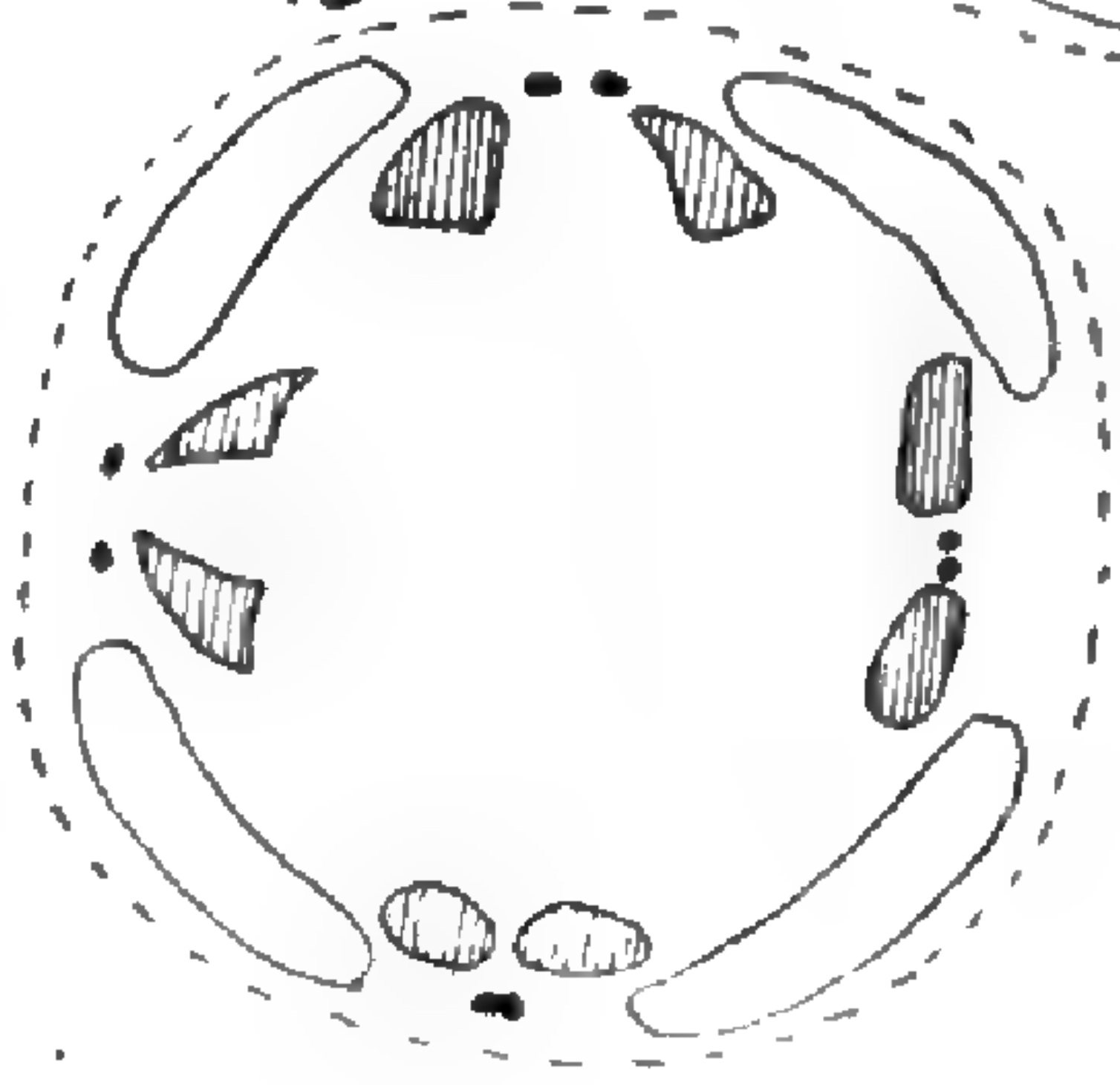

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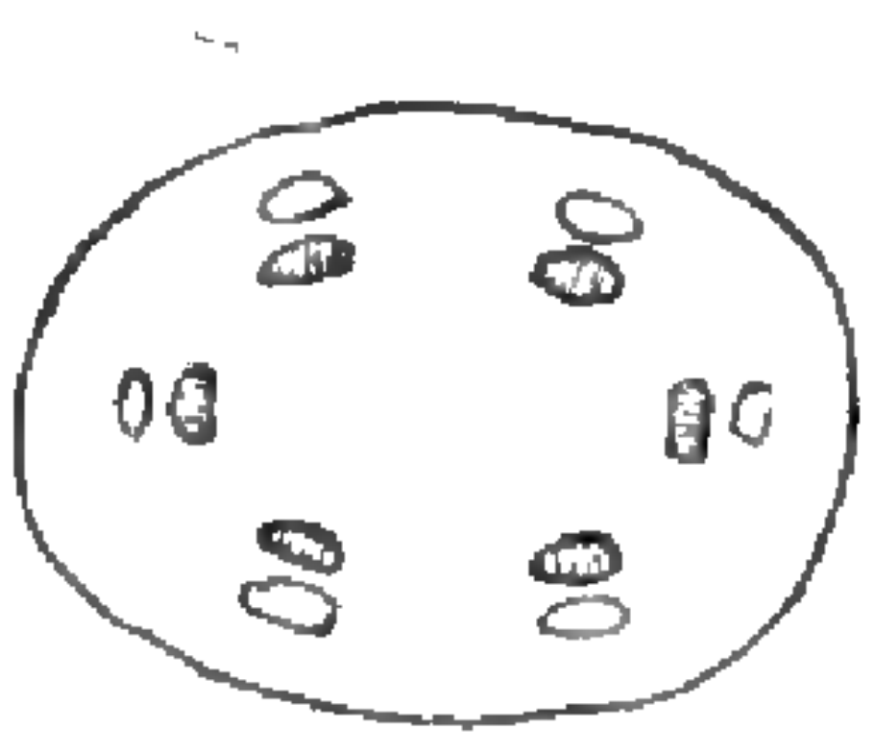

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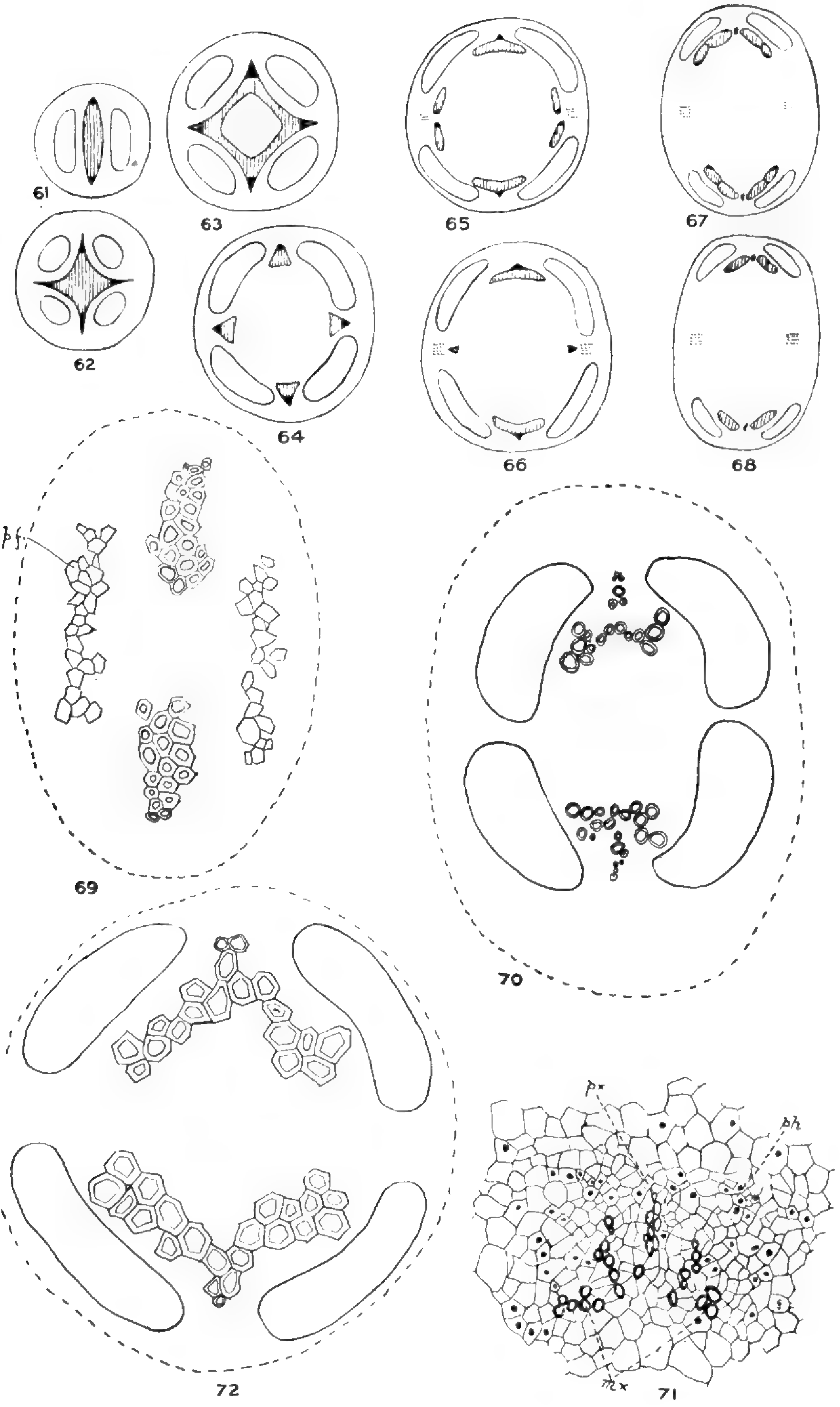

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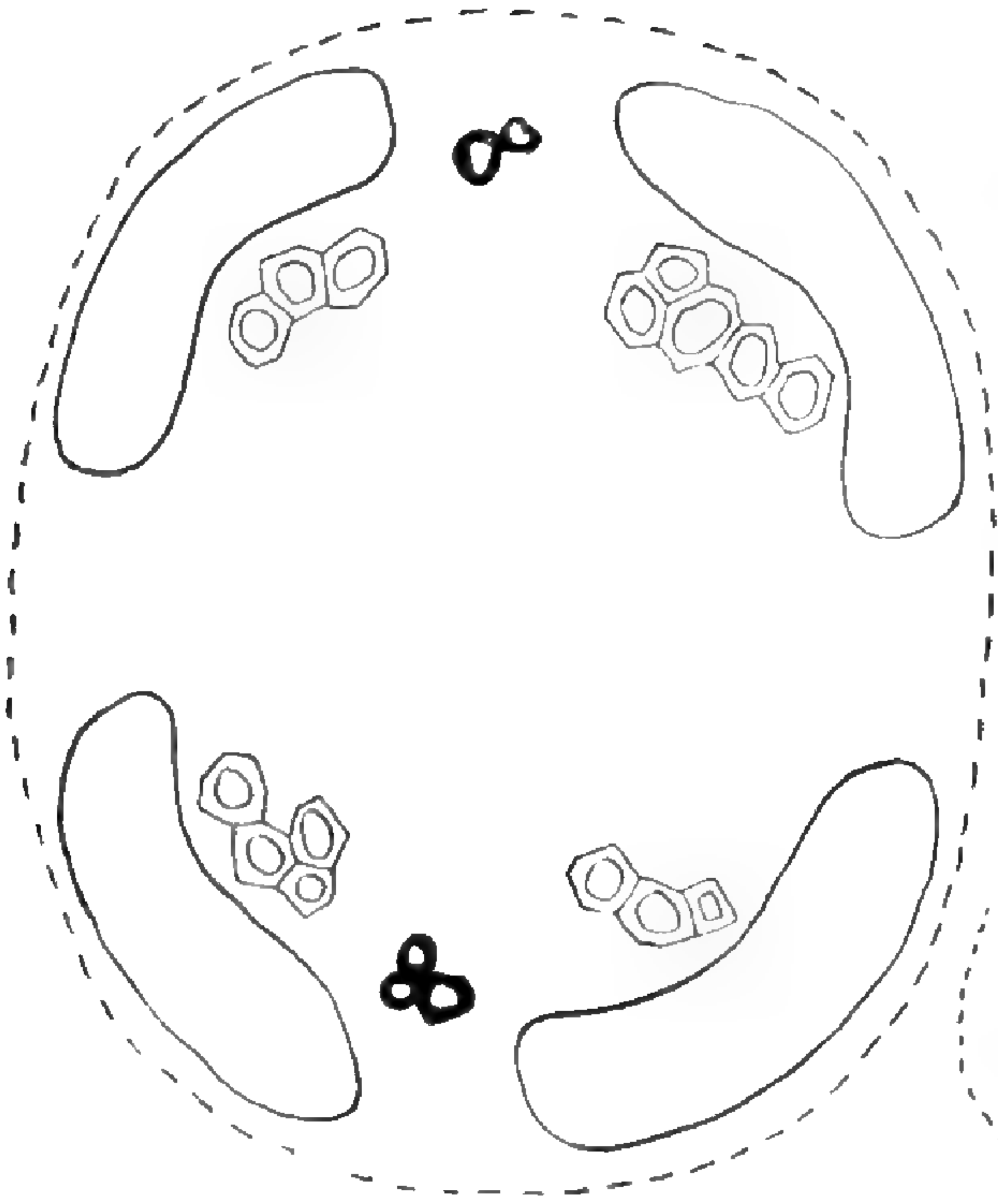

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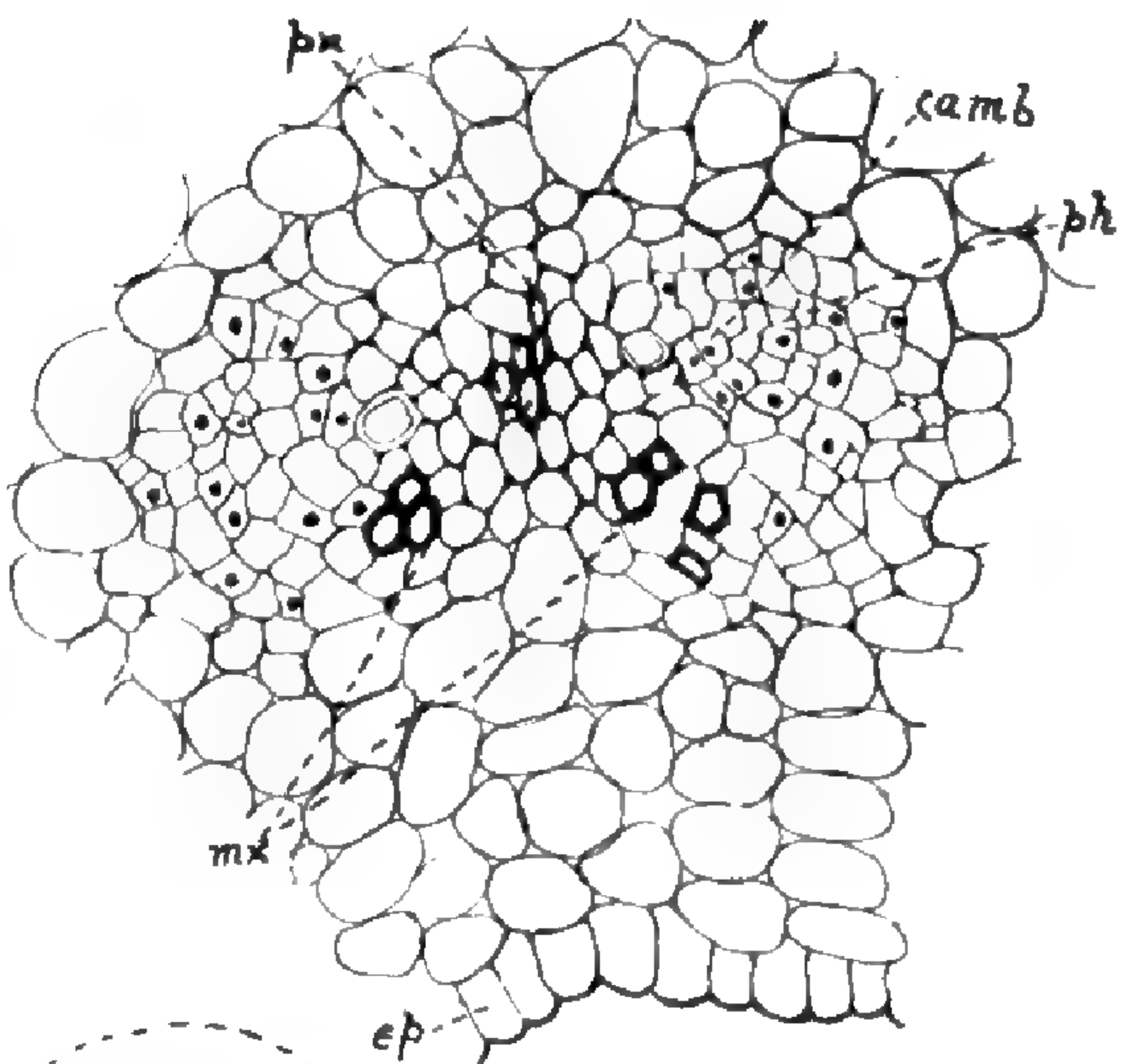

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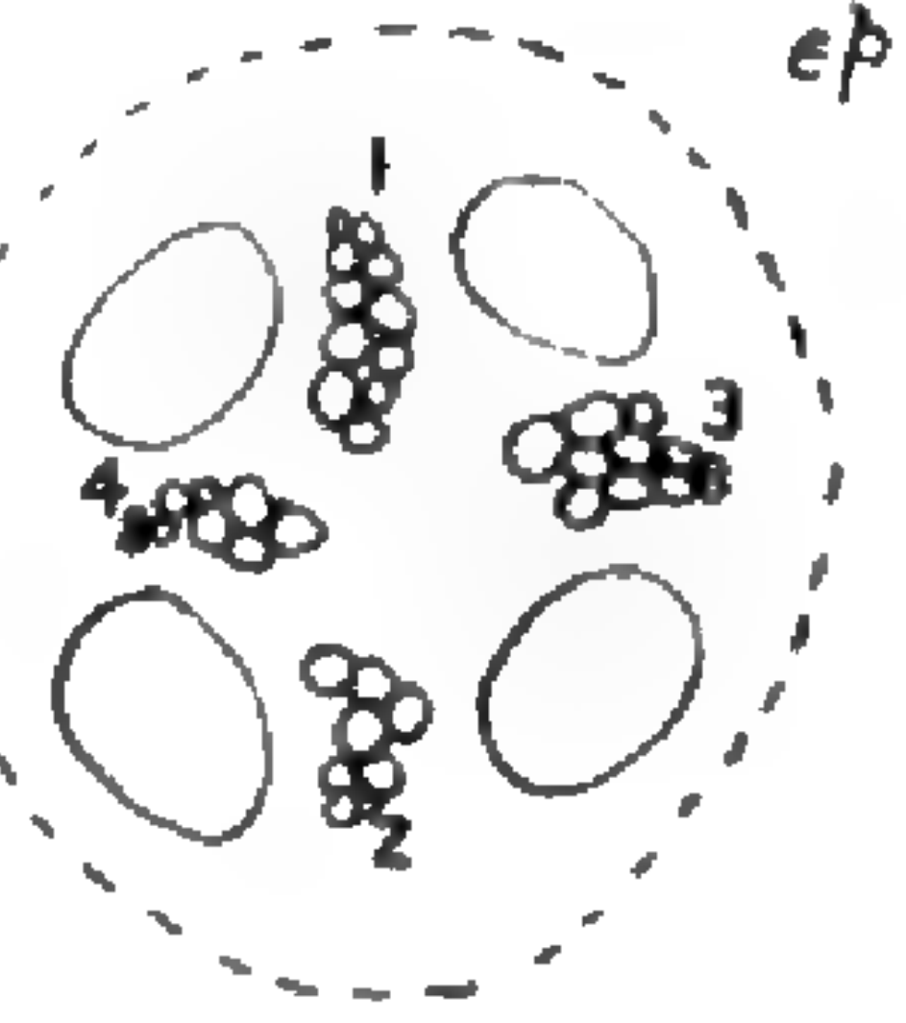

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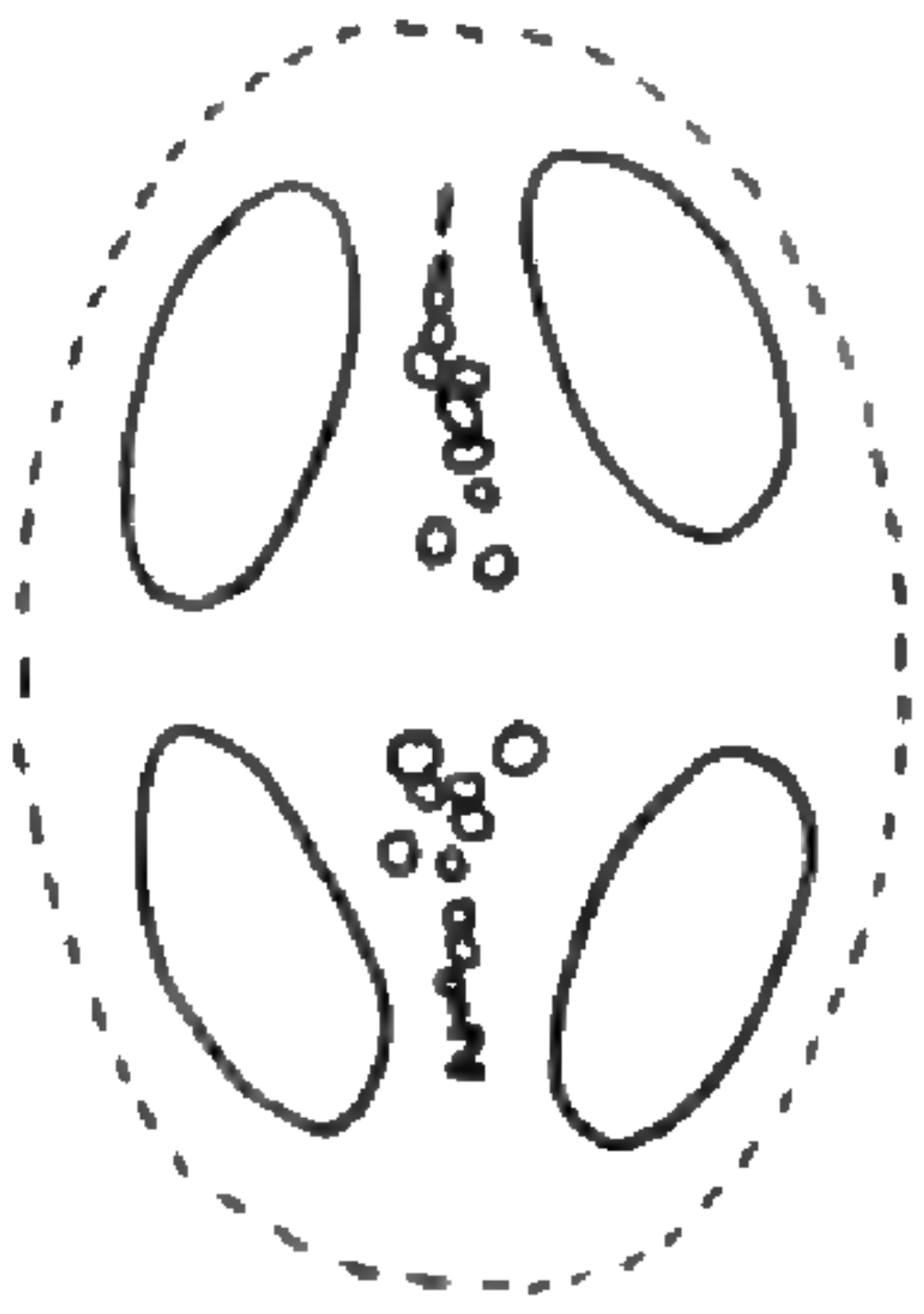

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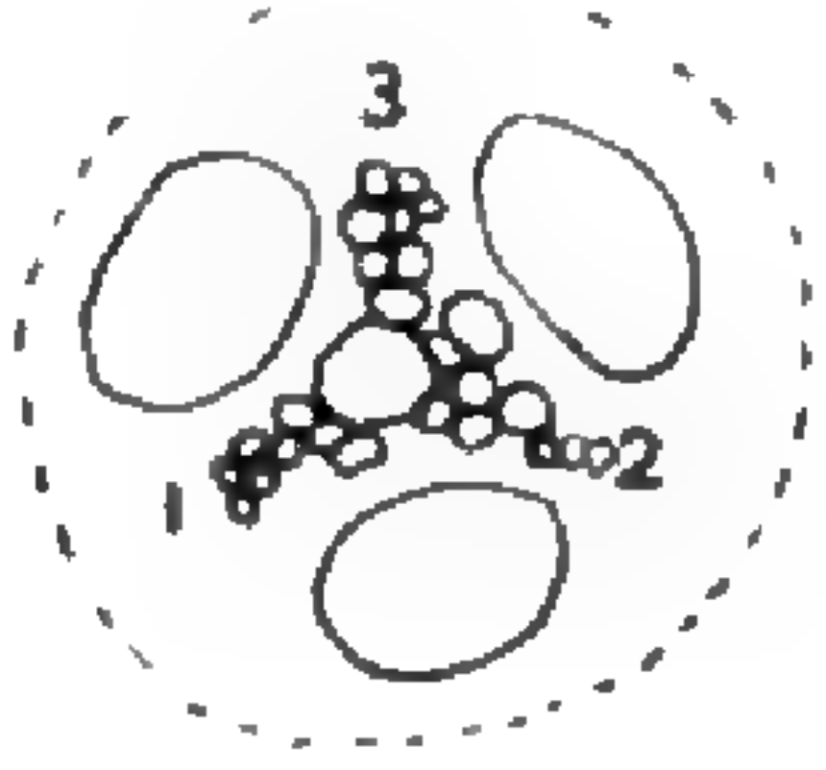

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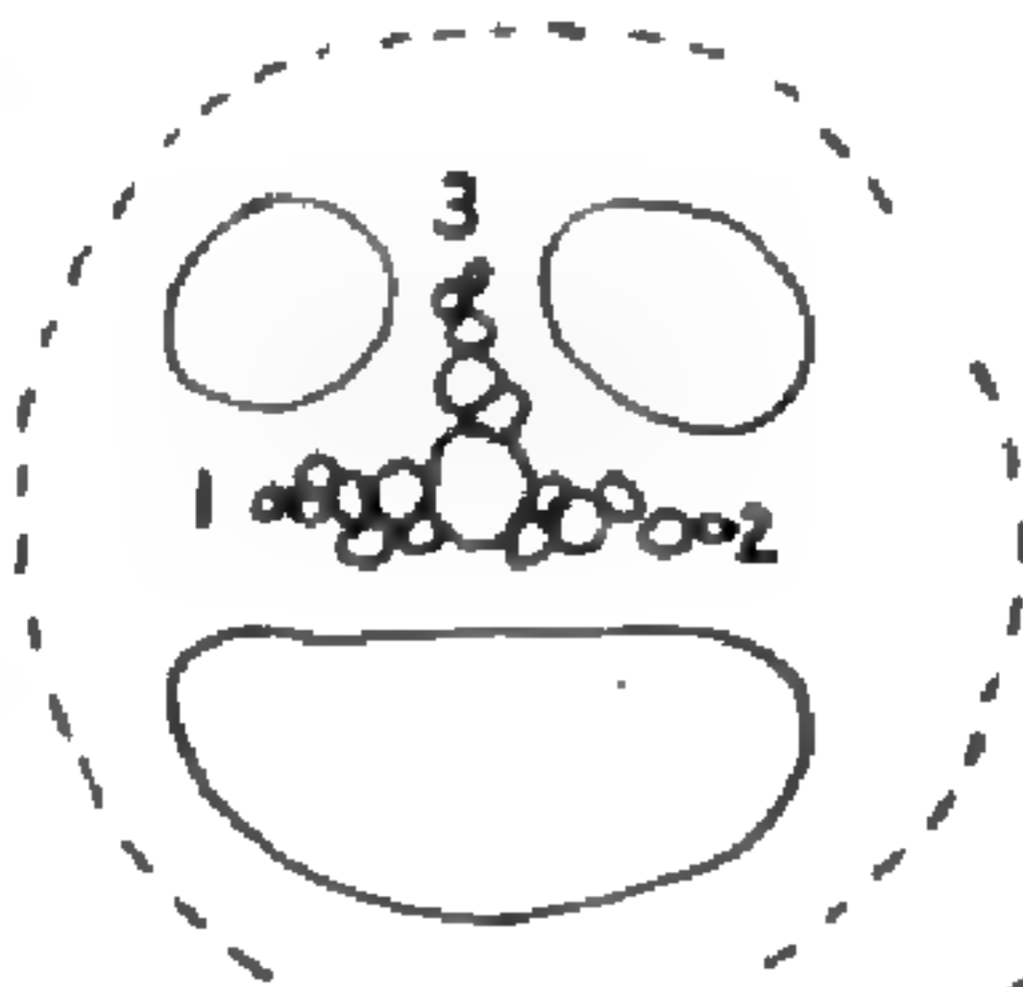

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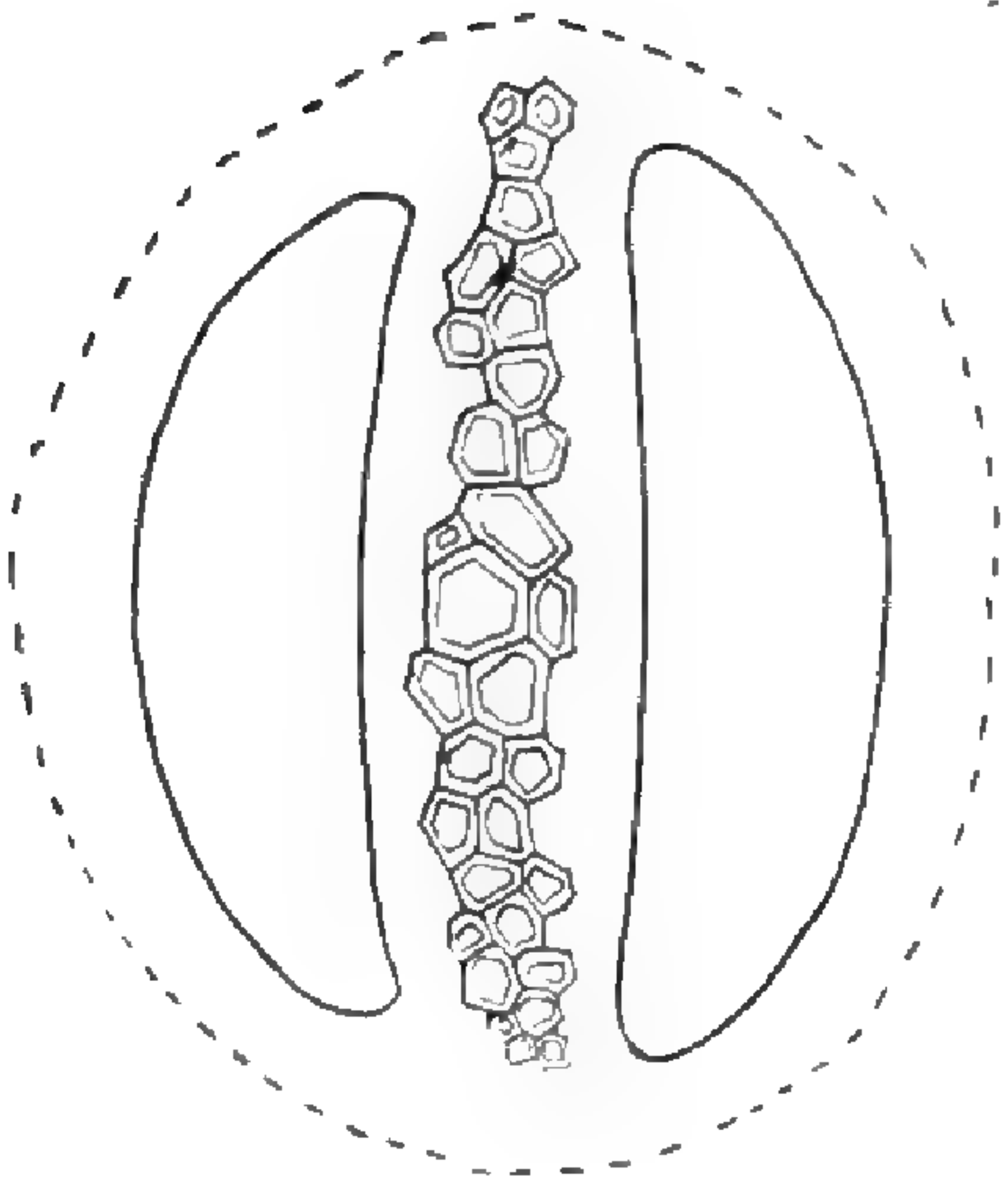

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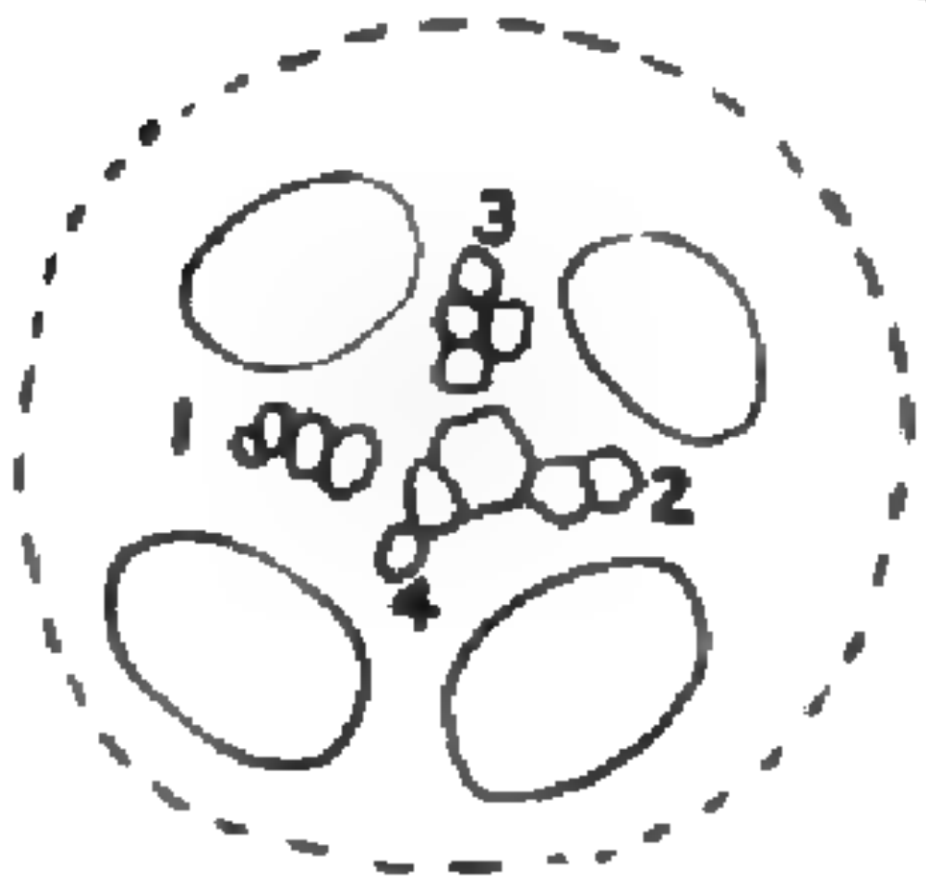

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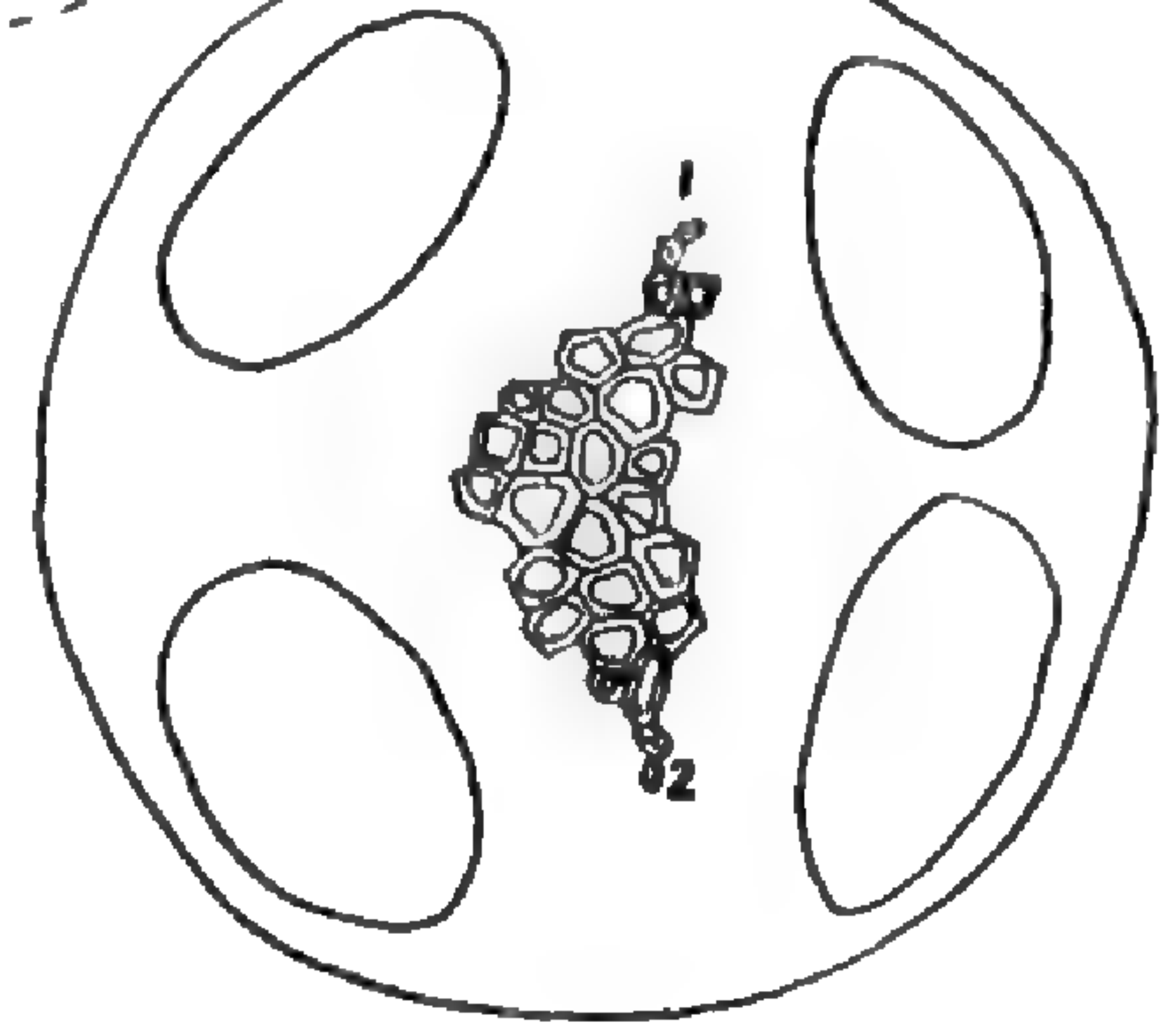

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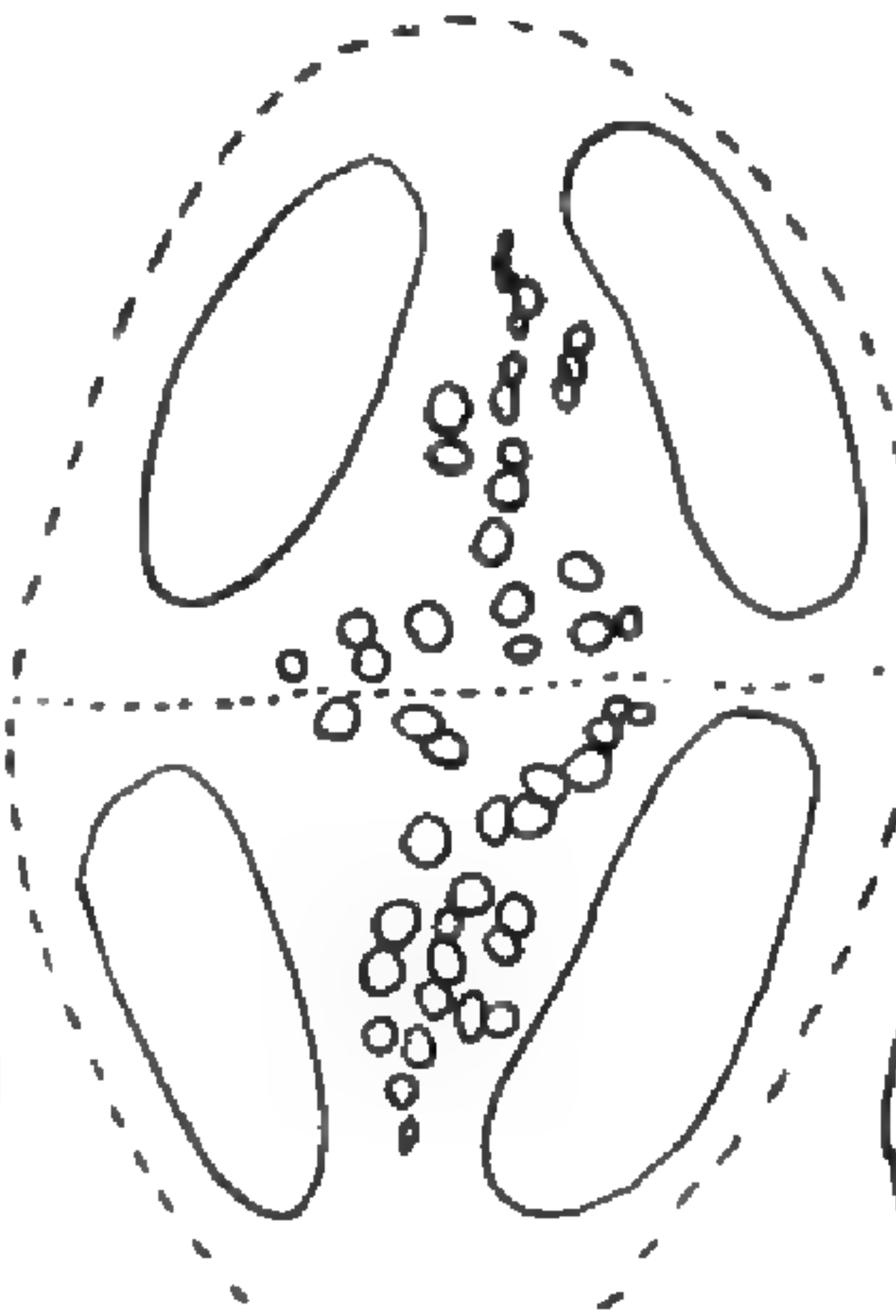

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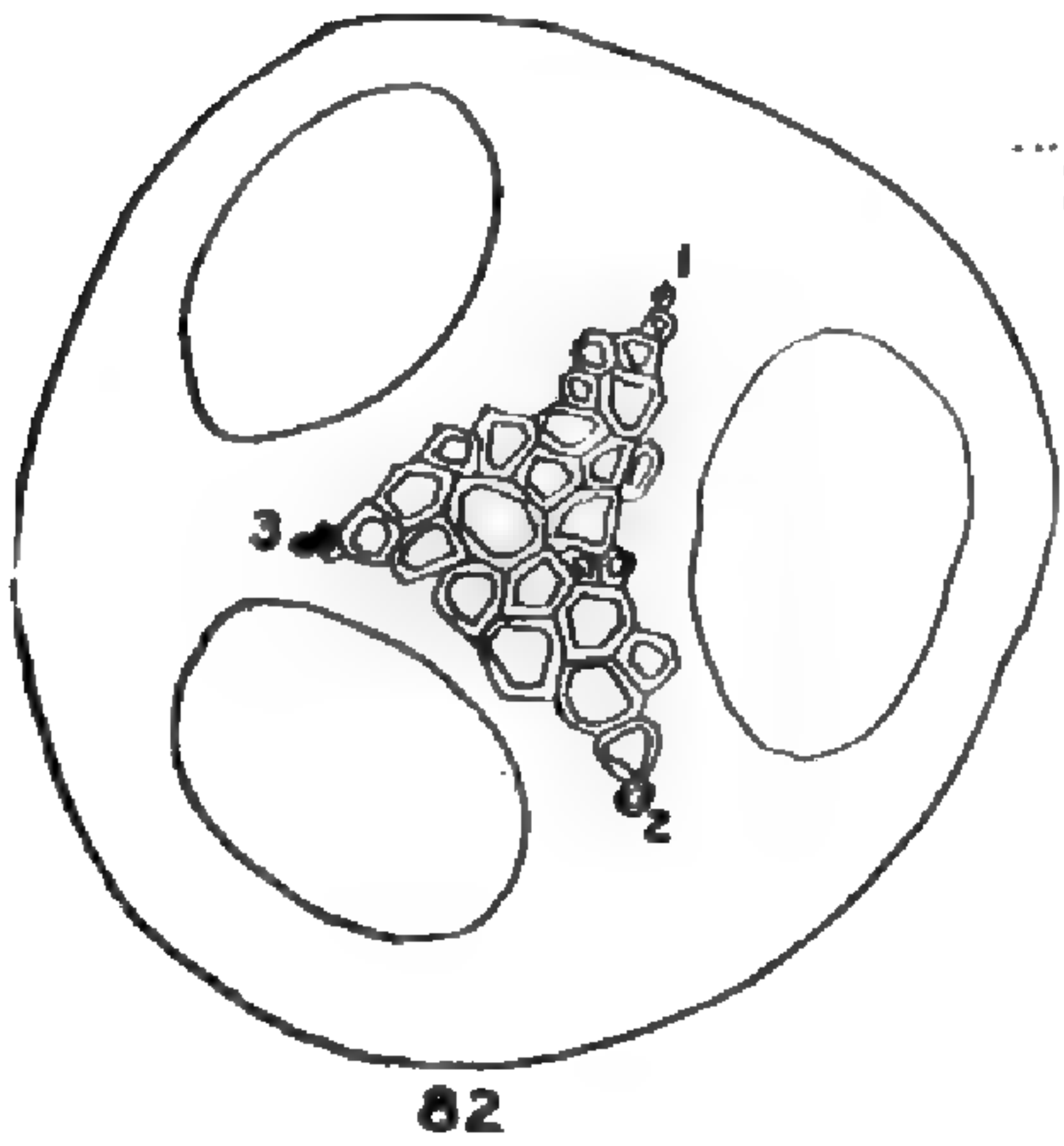

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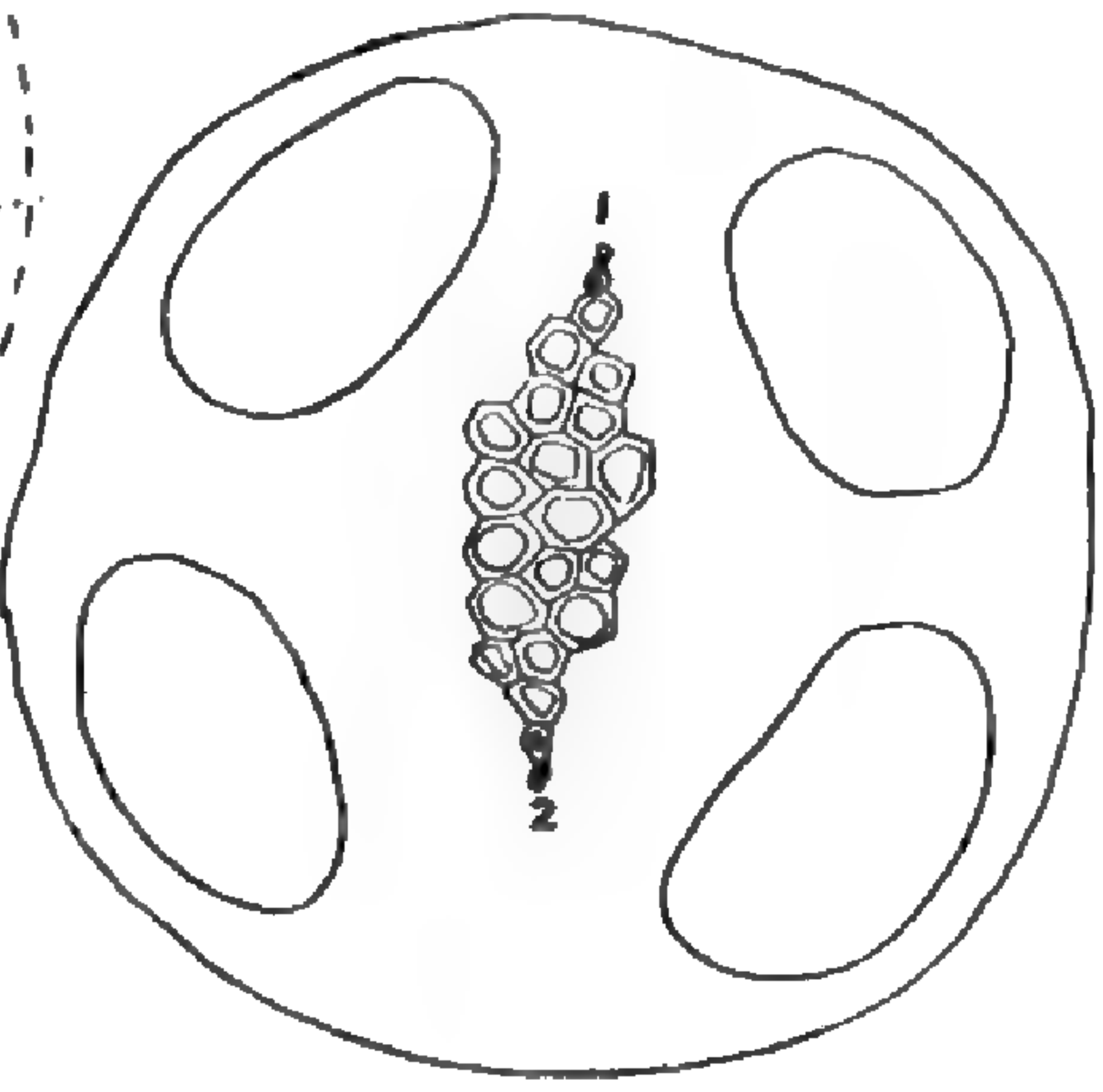

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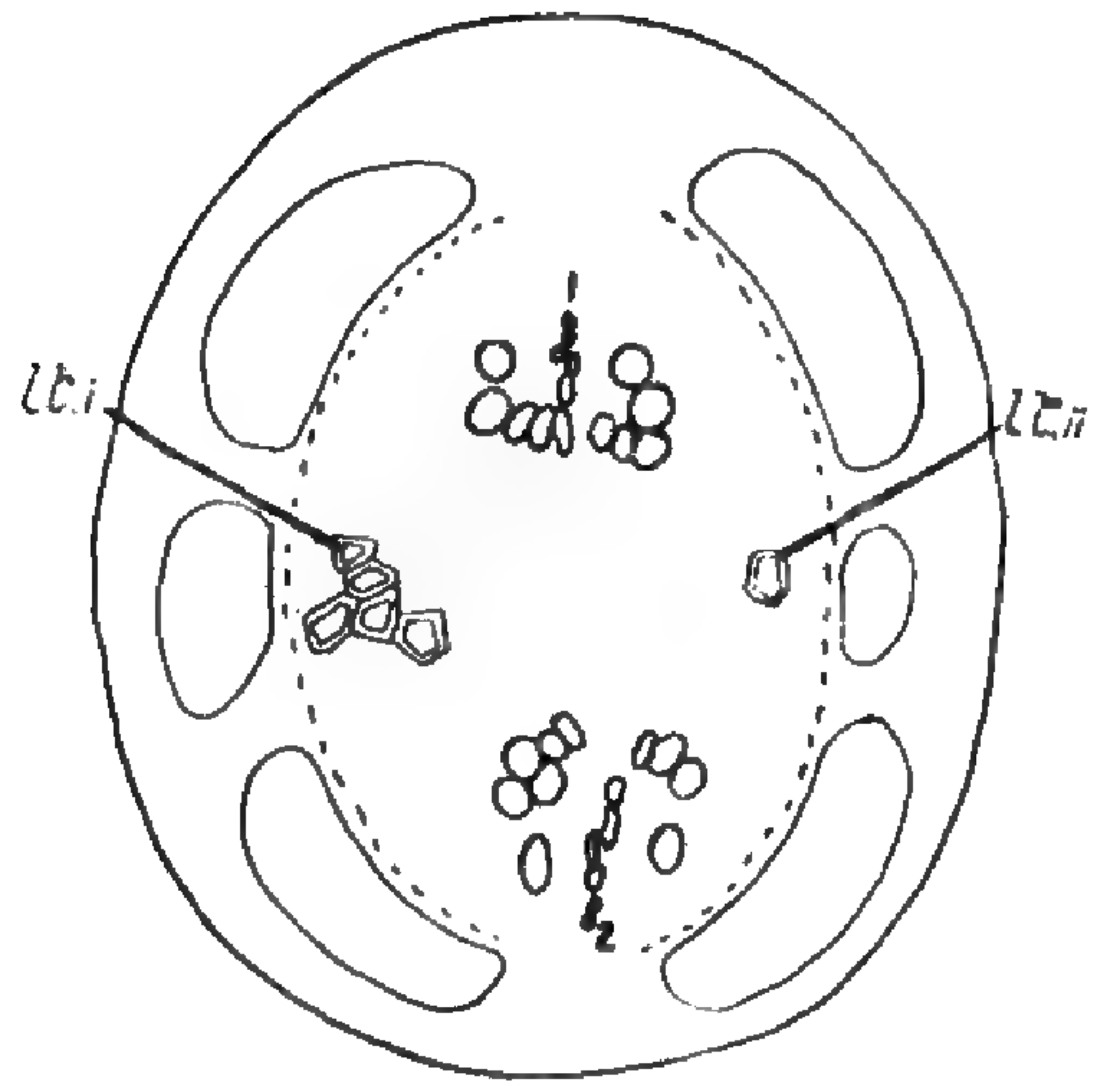

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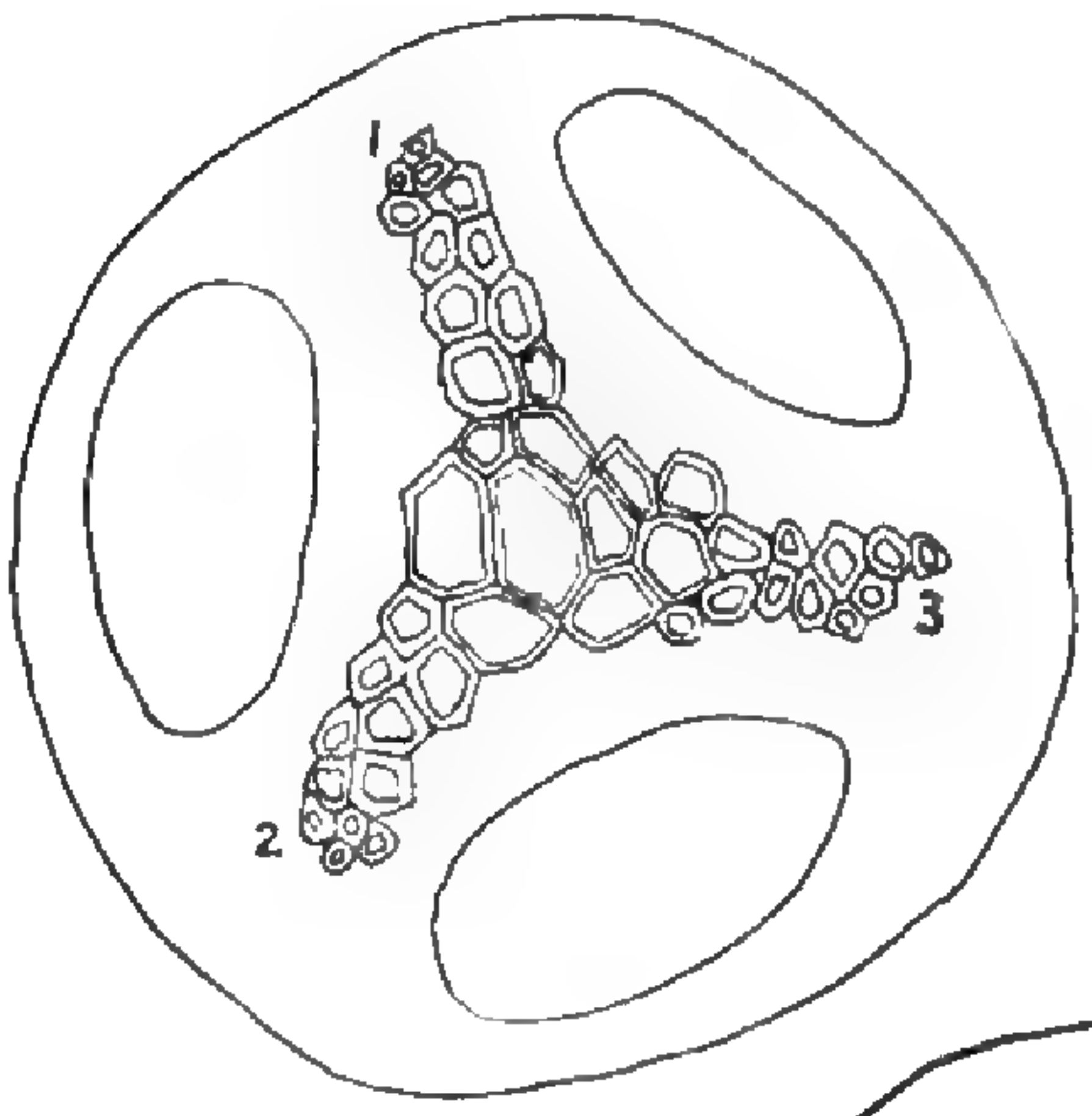

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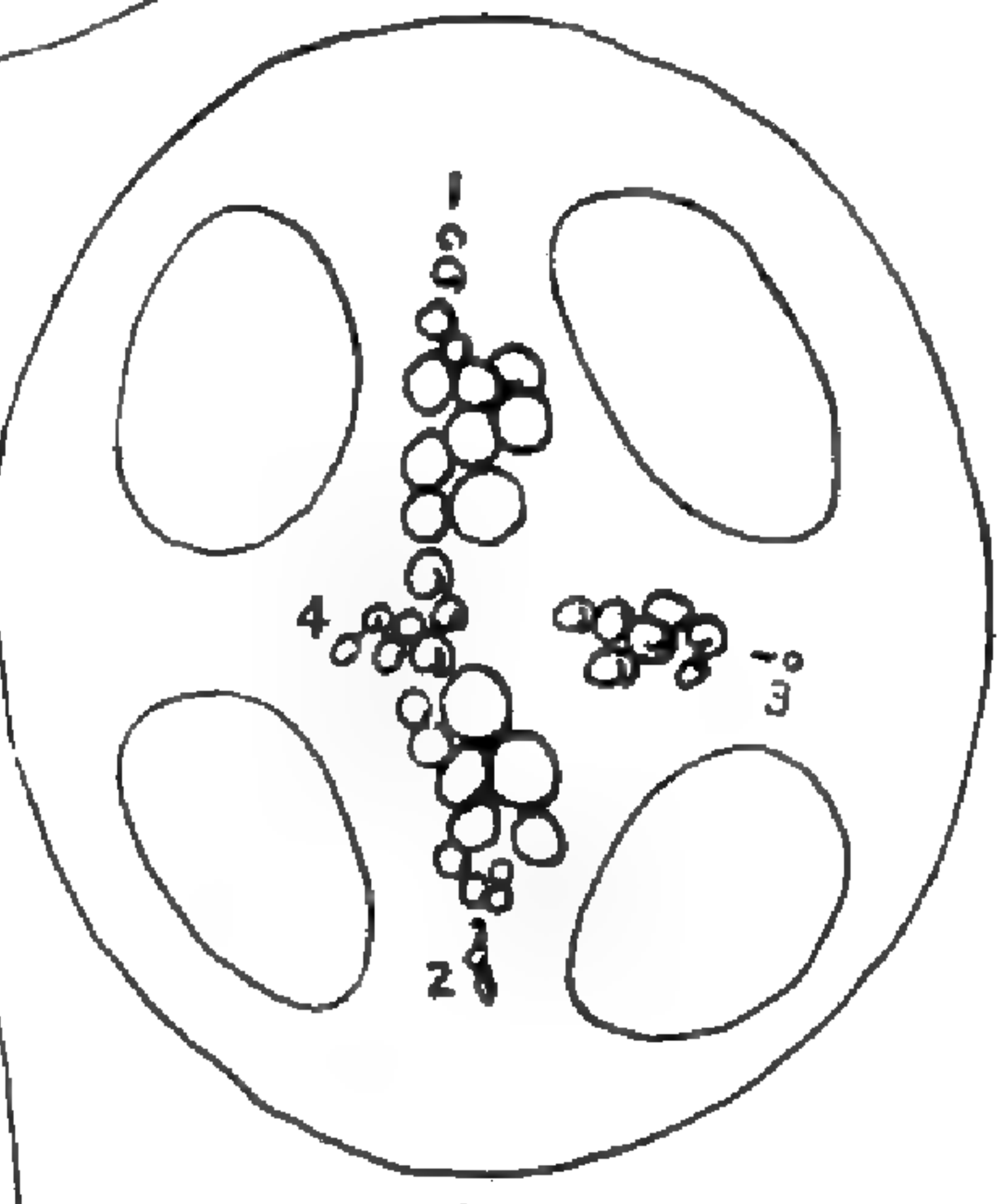

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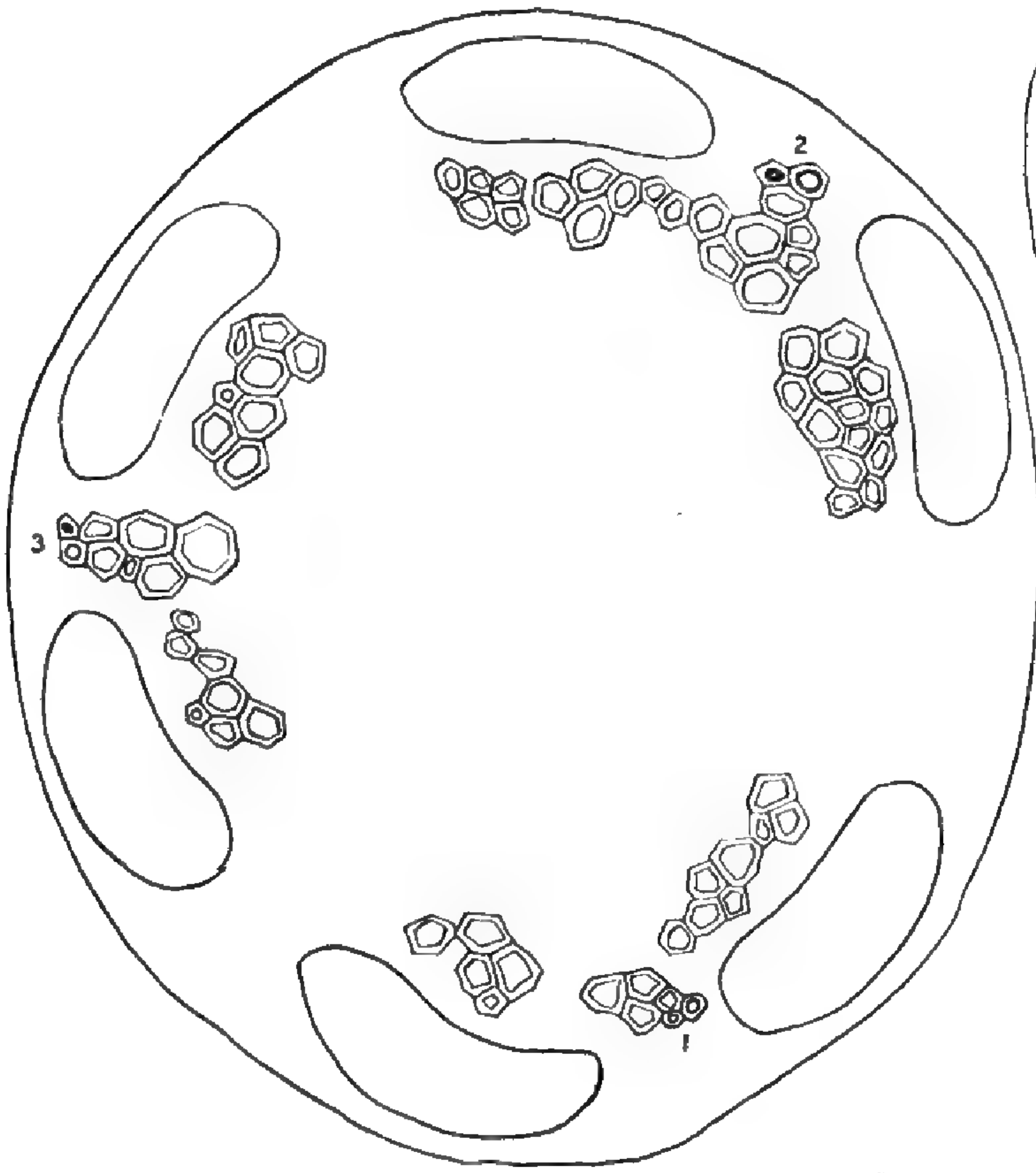

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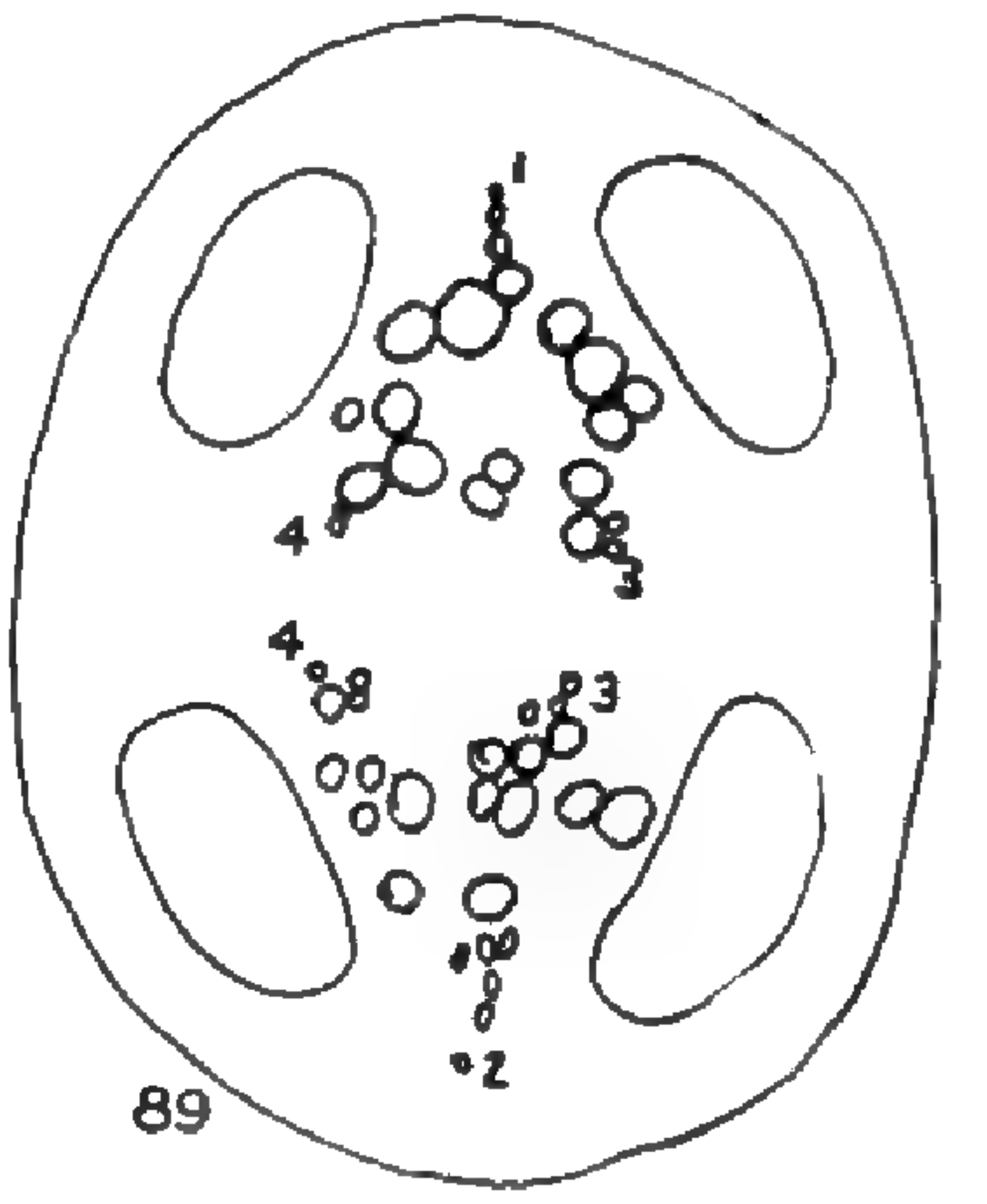

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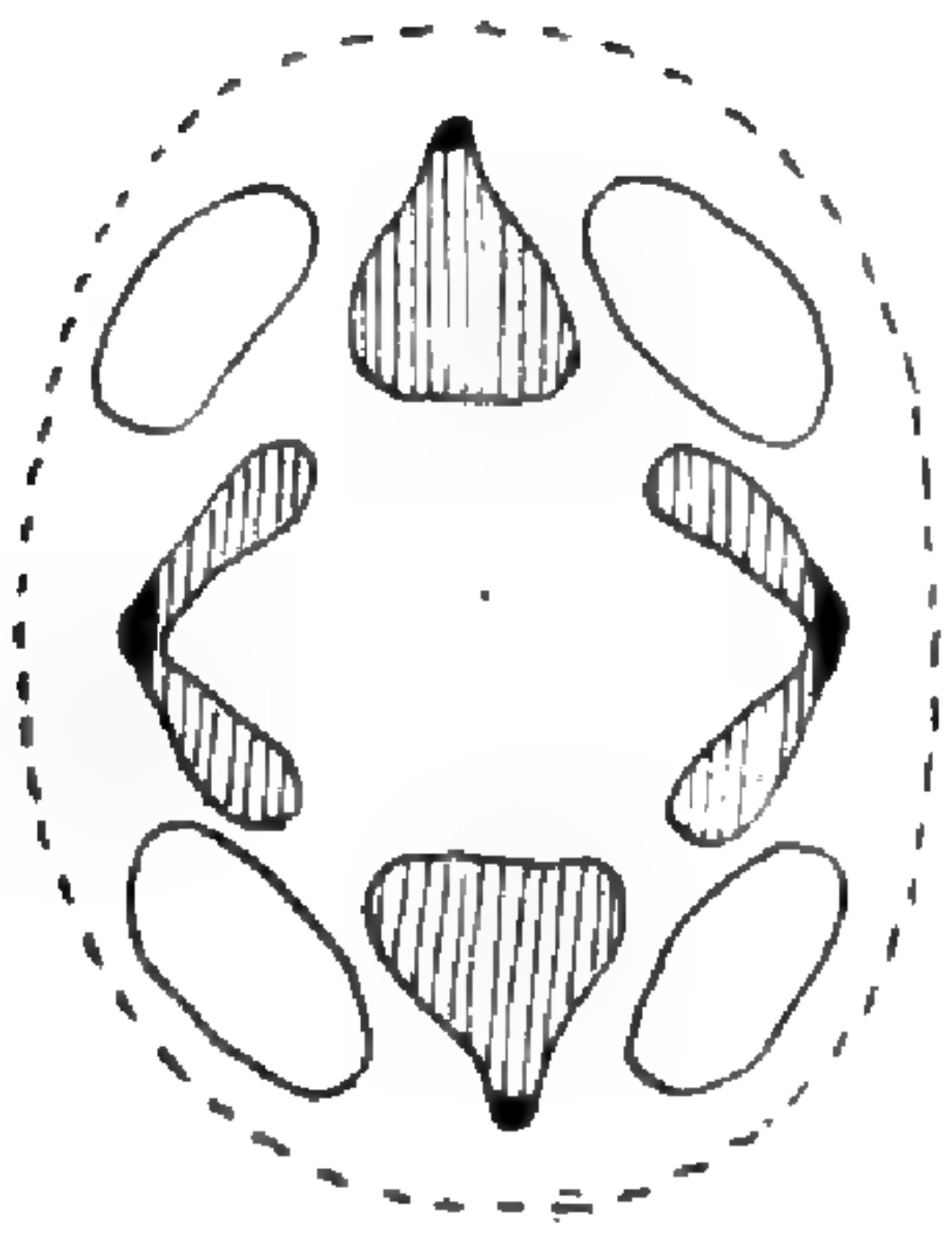

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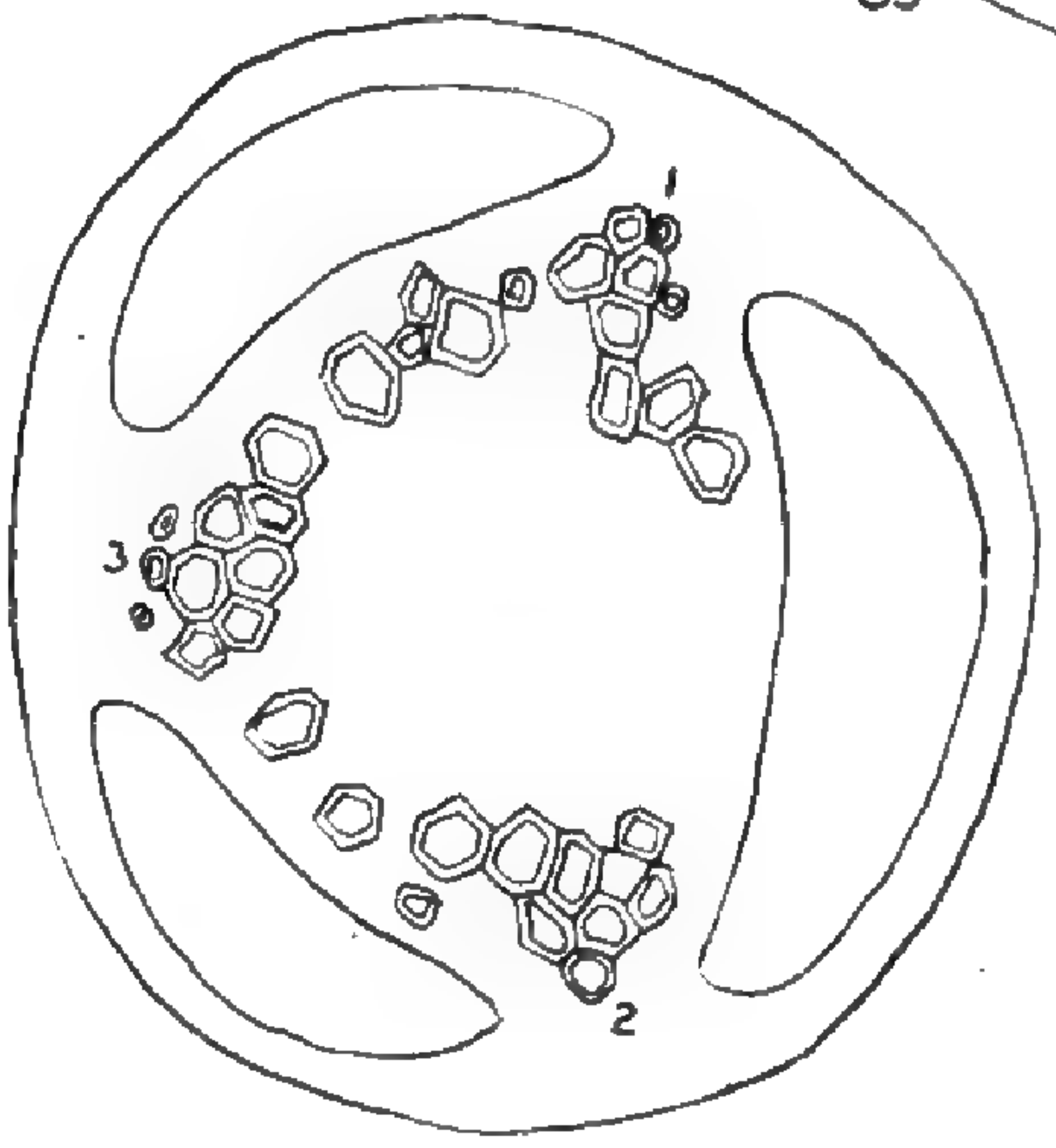

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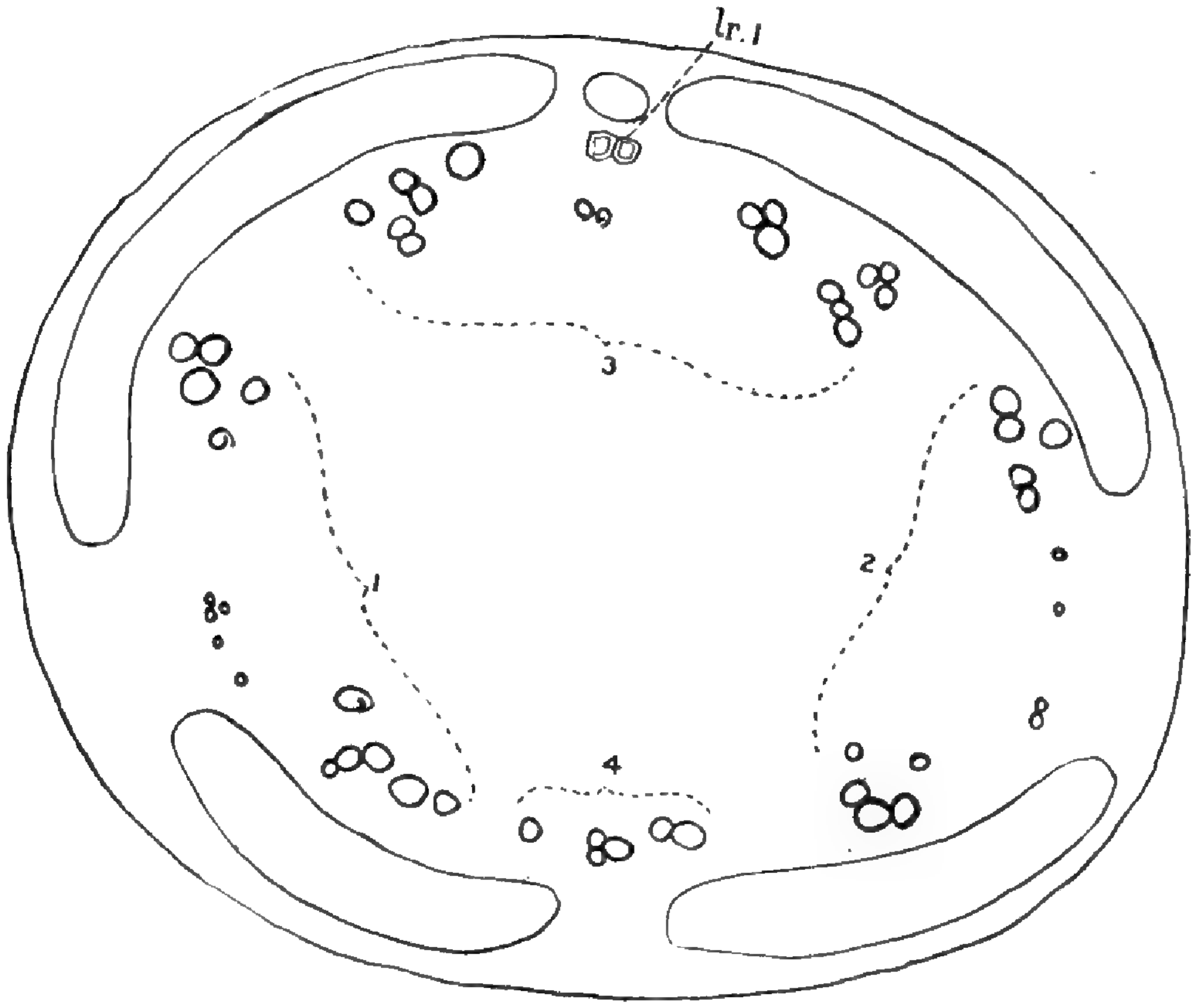

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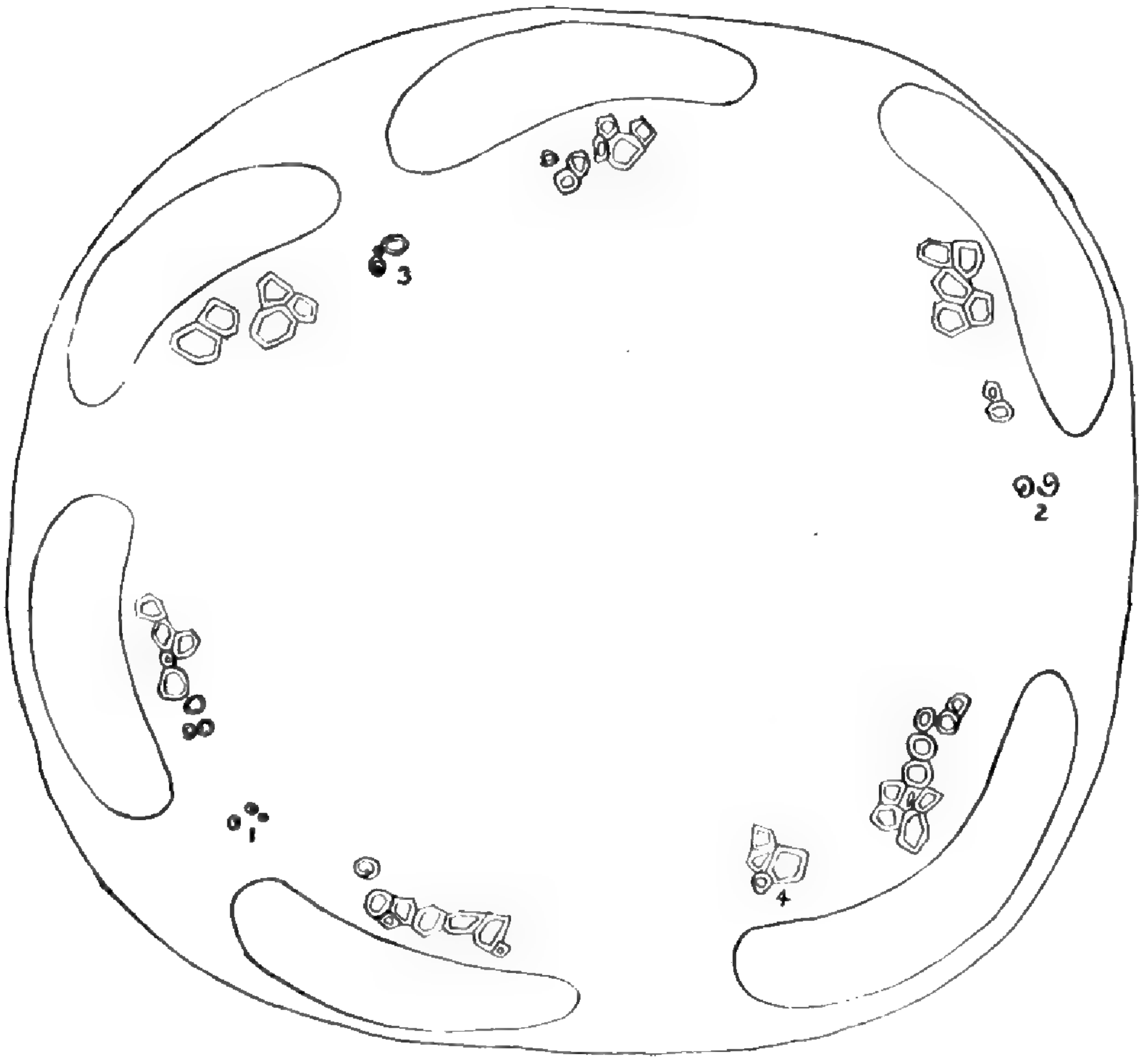

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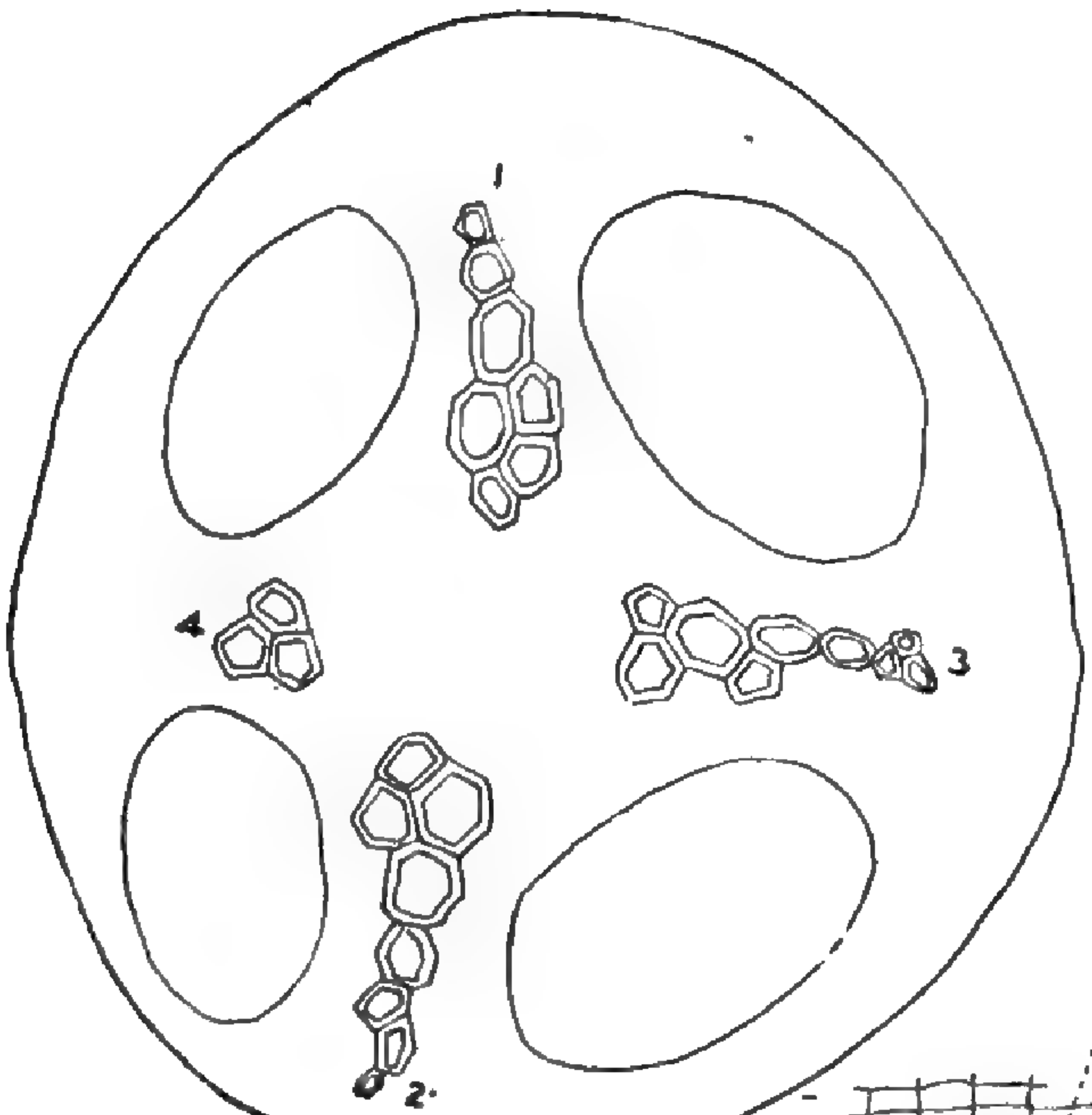

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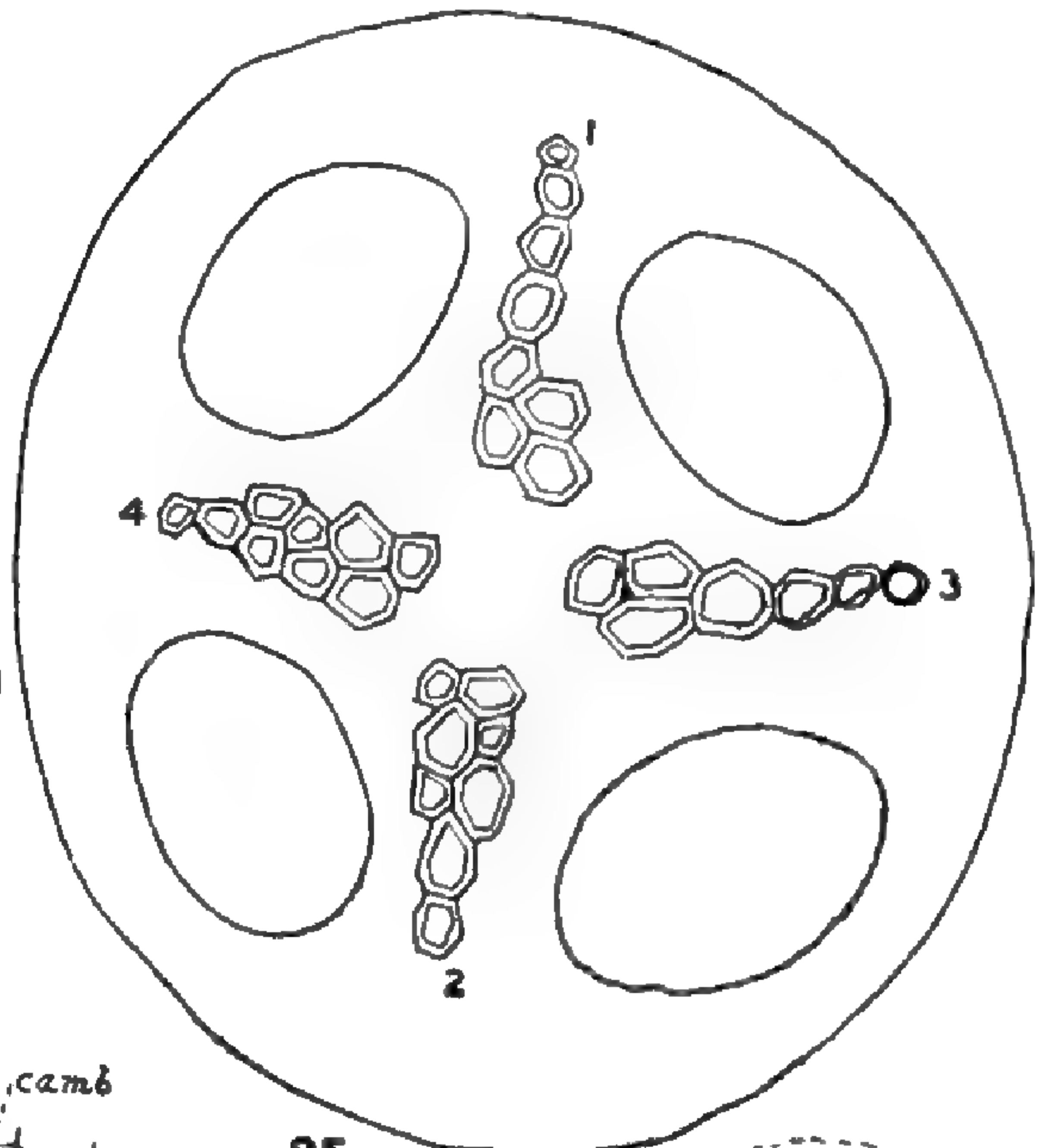

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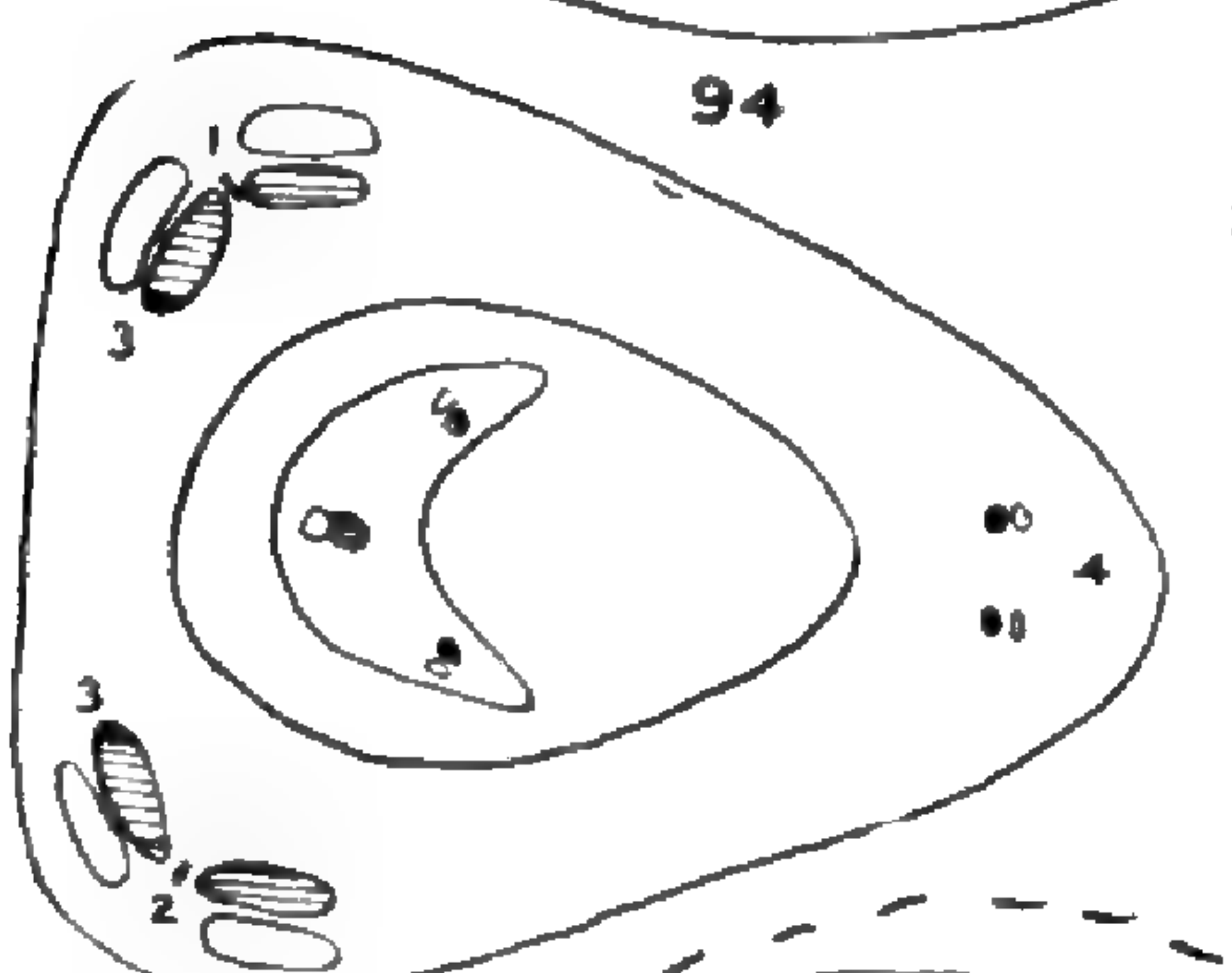

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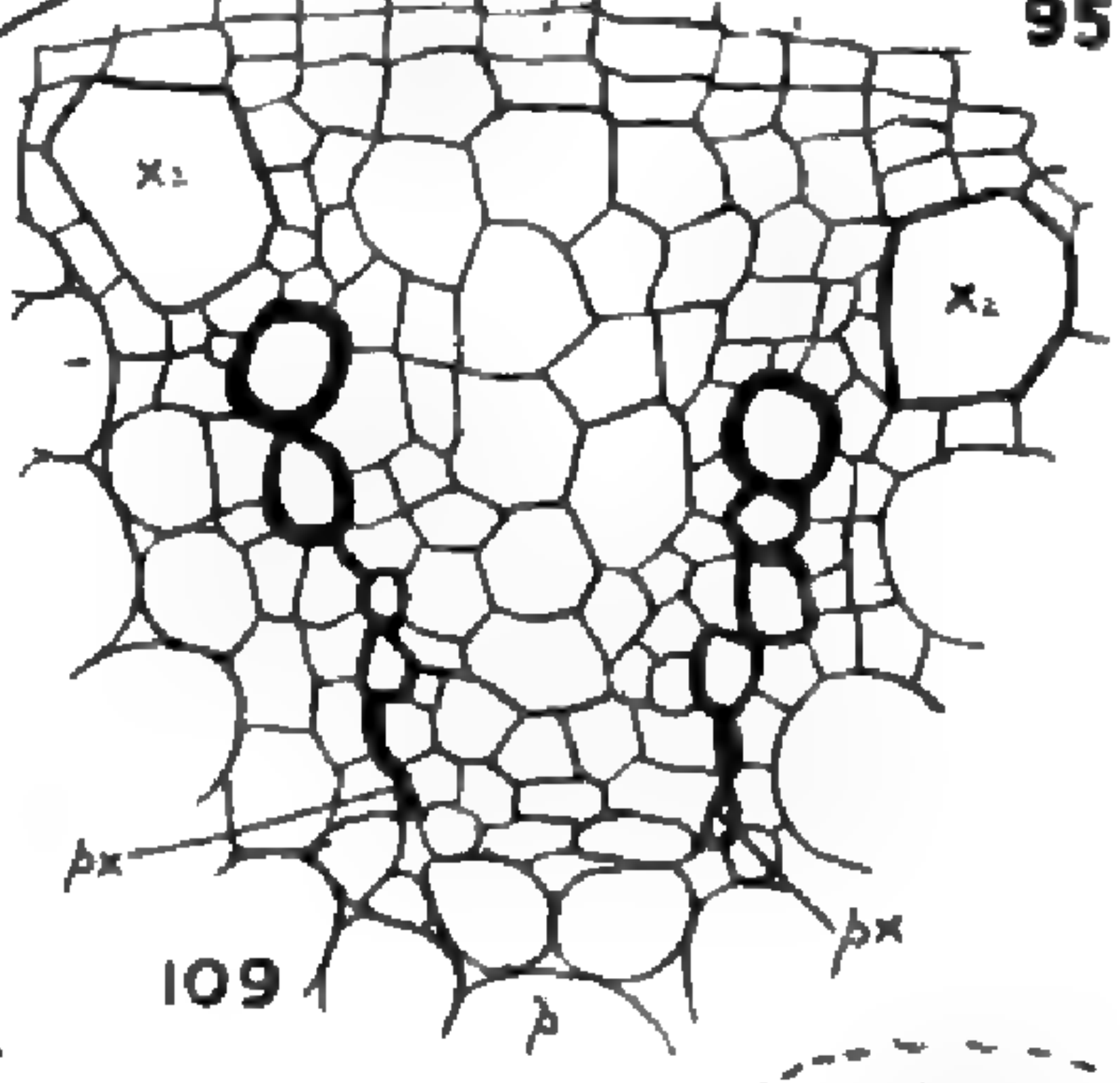

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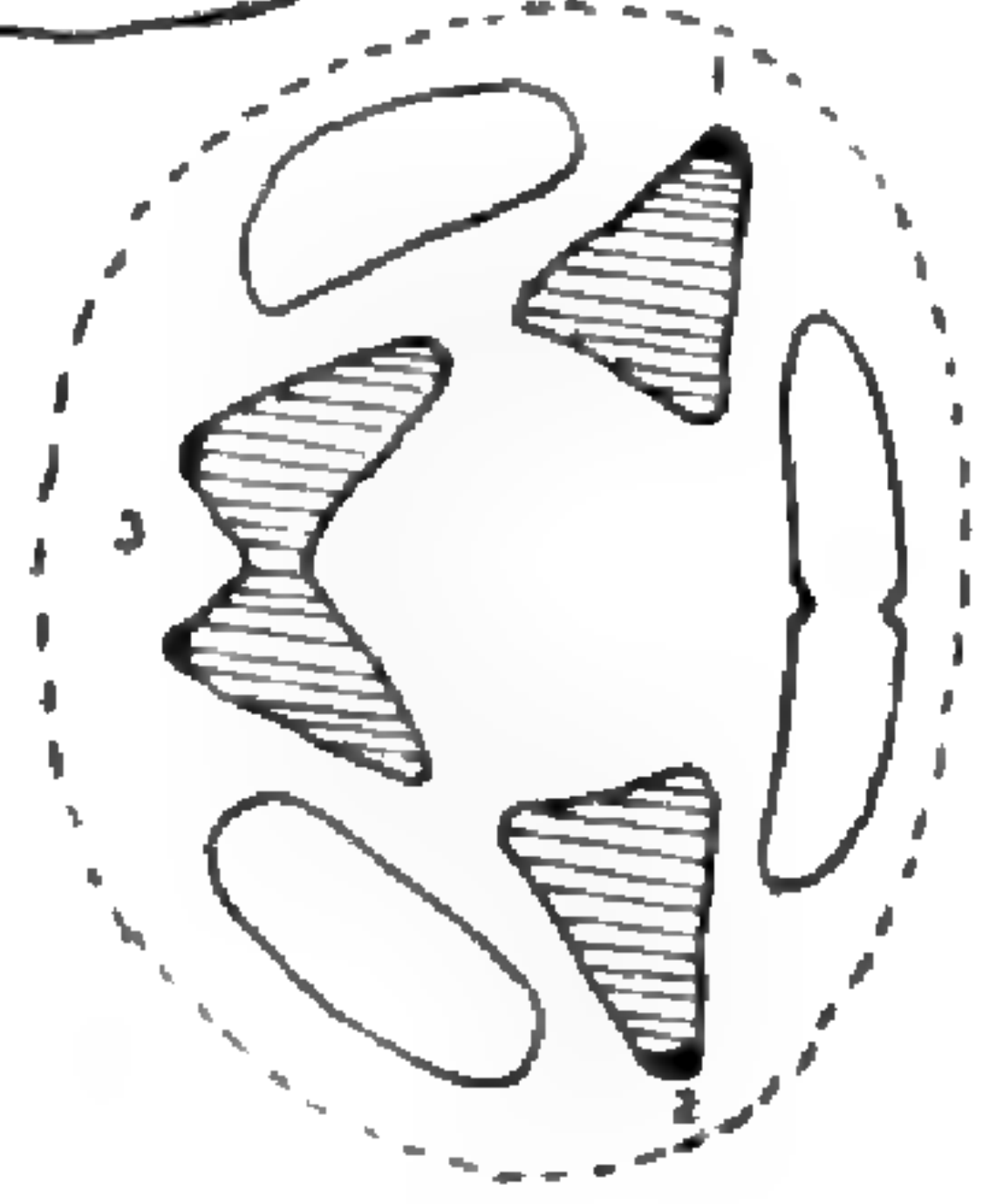

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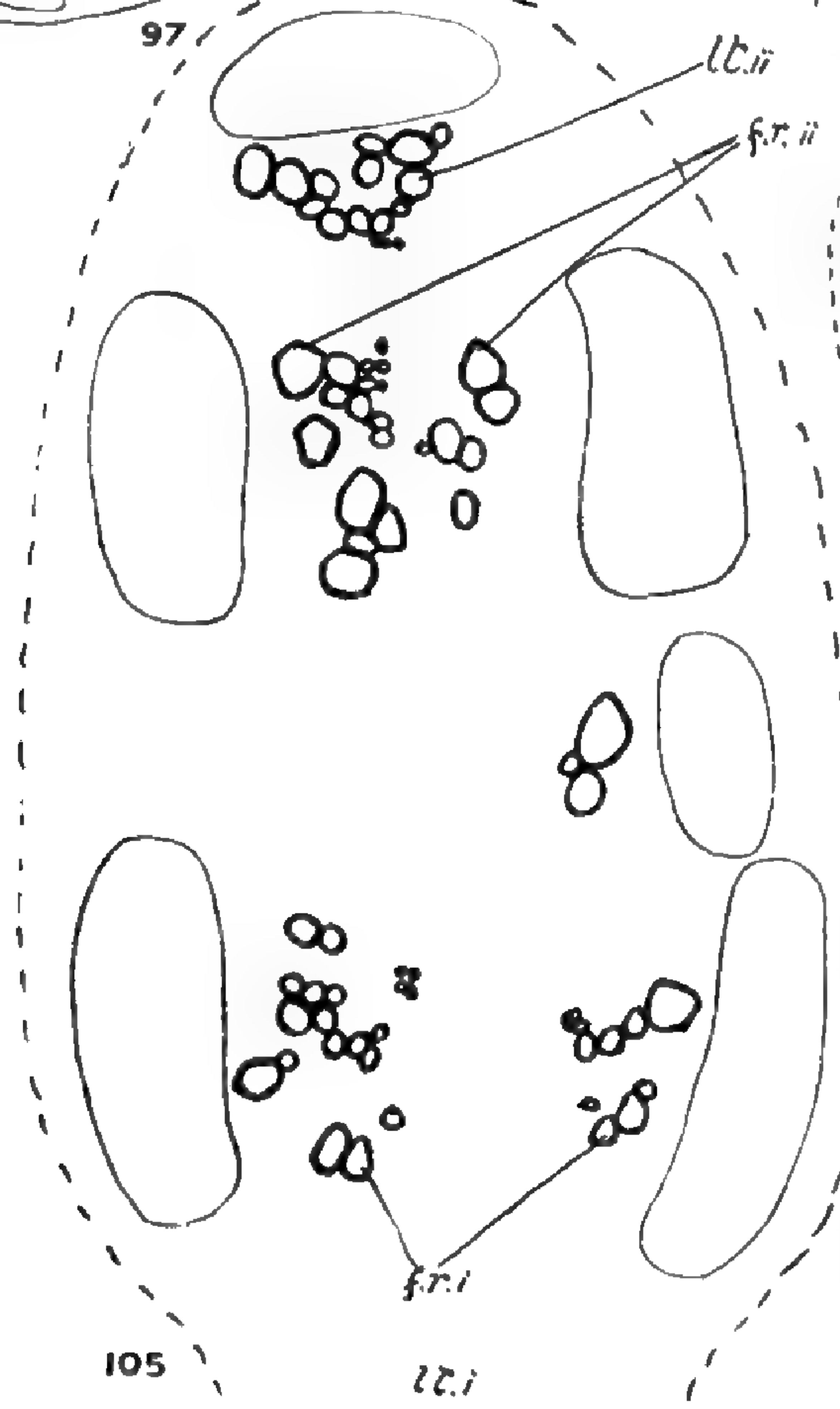

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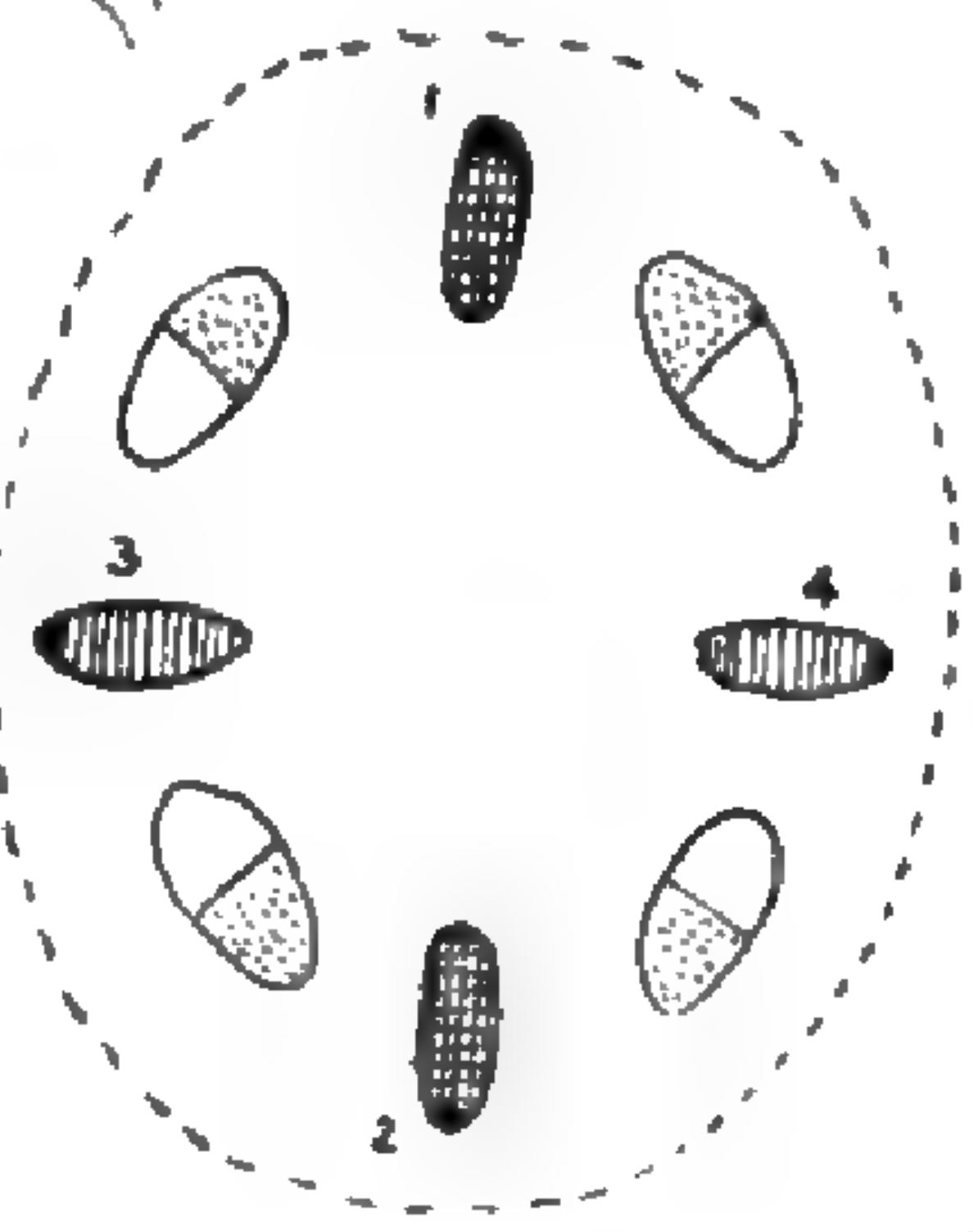

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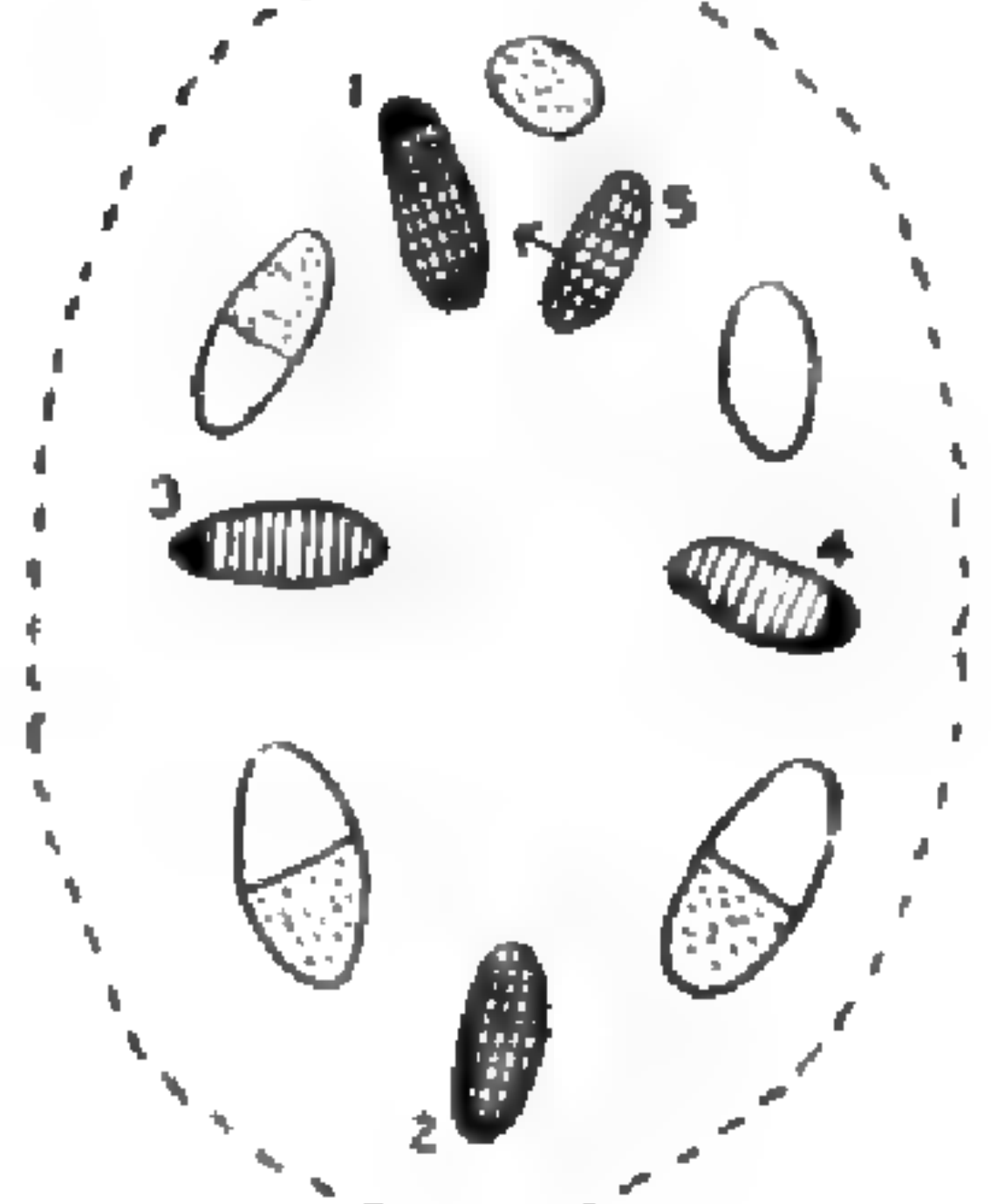

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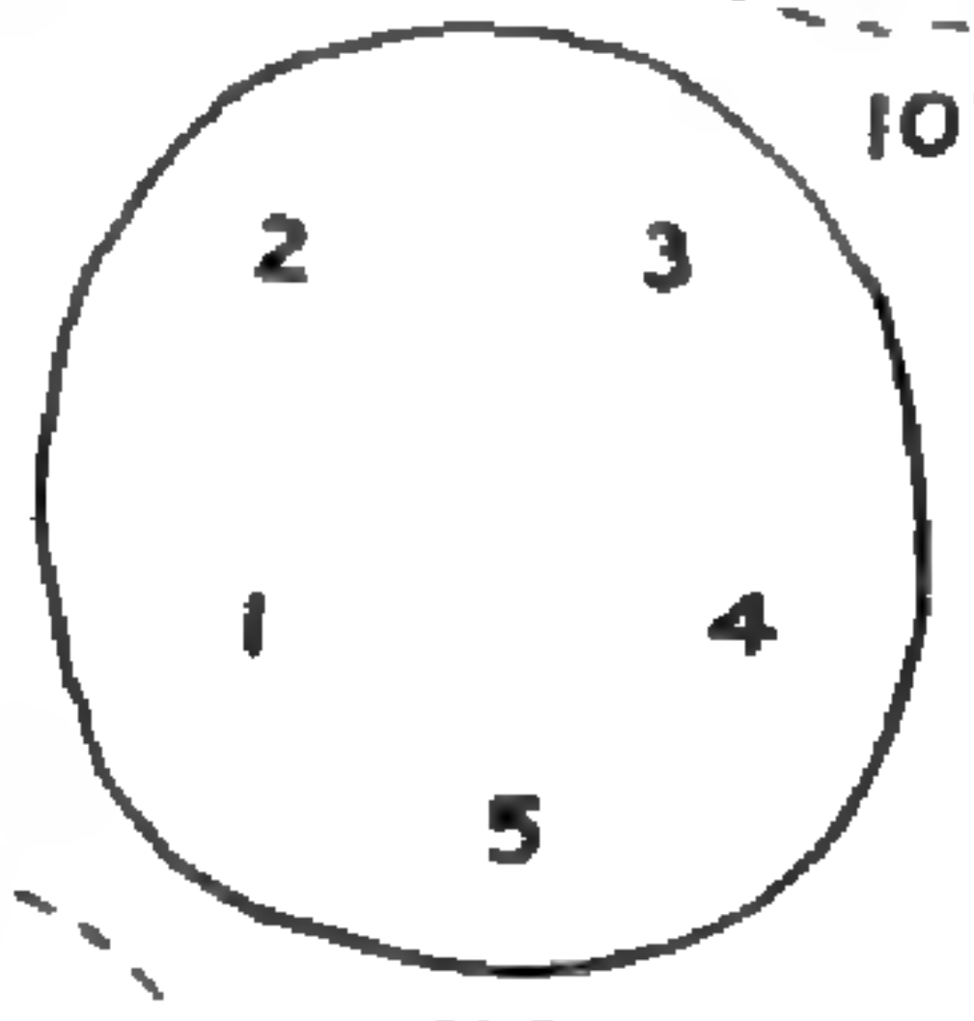

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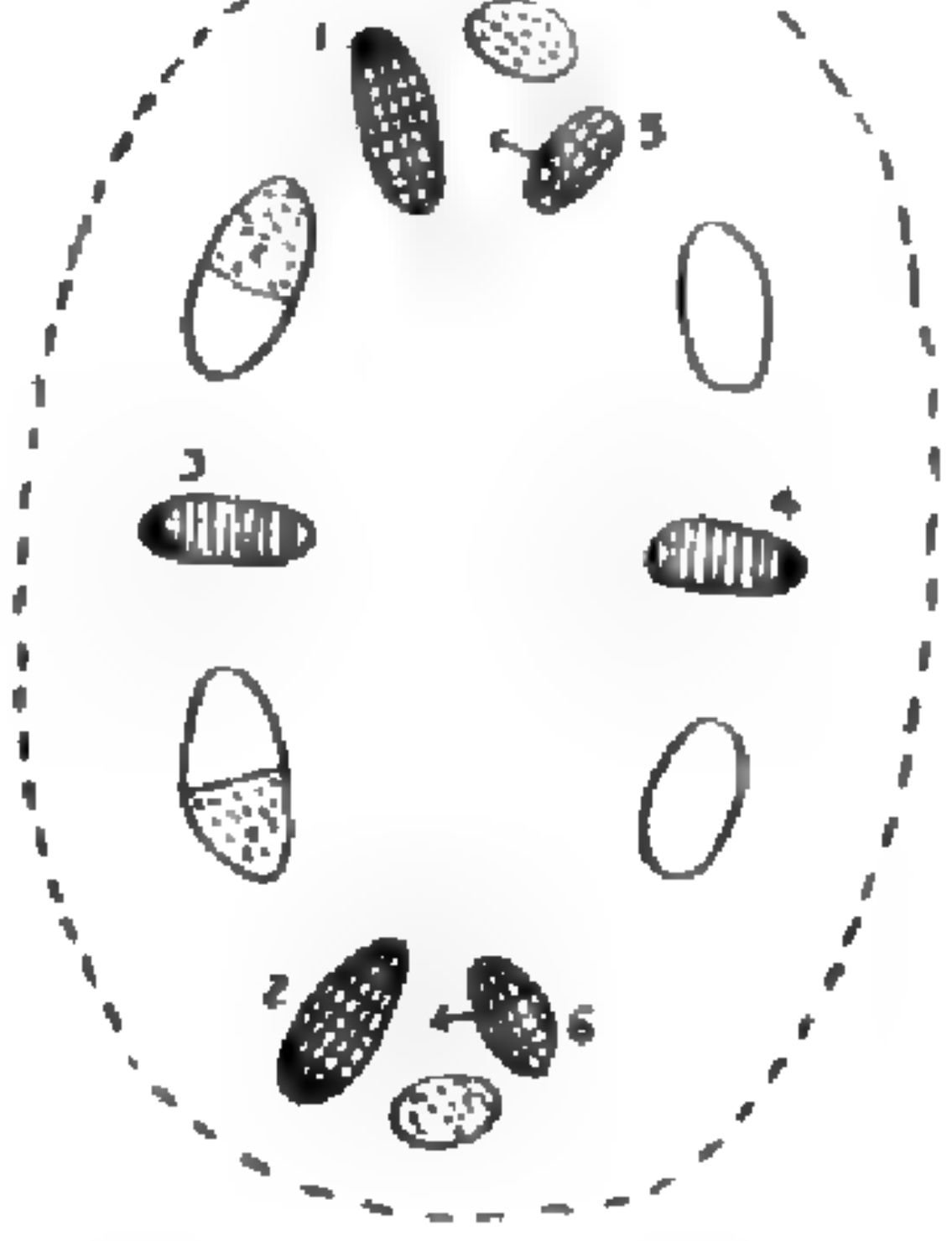

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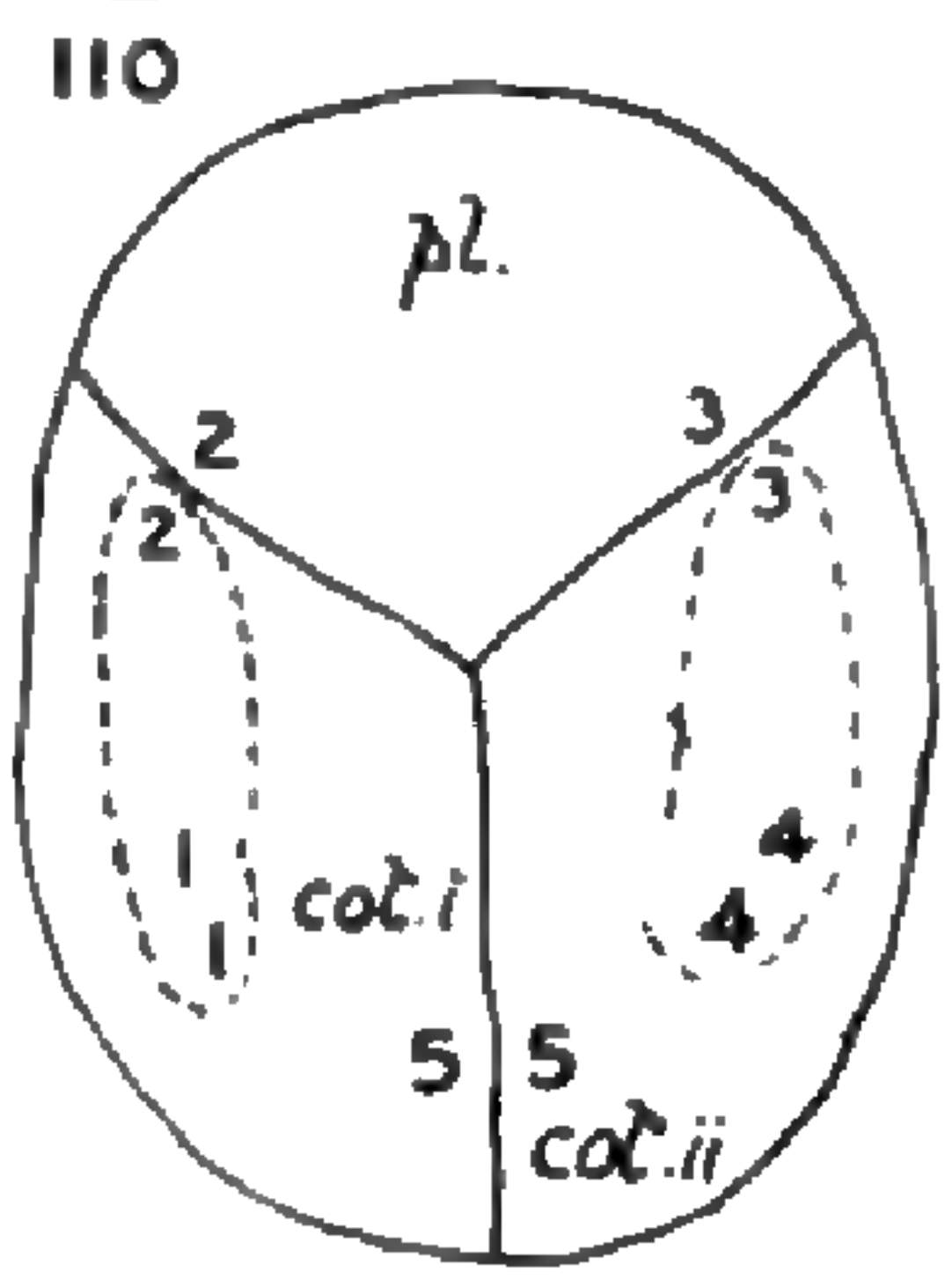

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R. H. C. del. Grout, sc.

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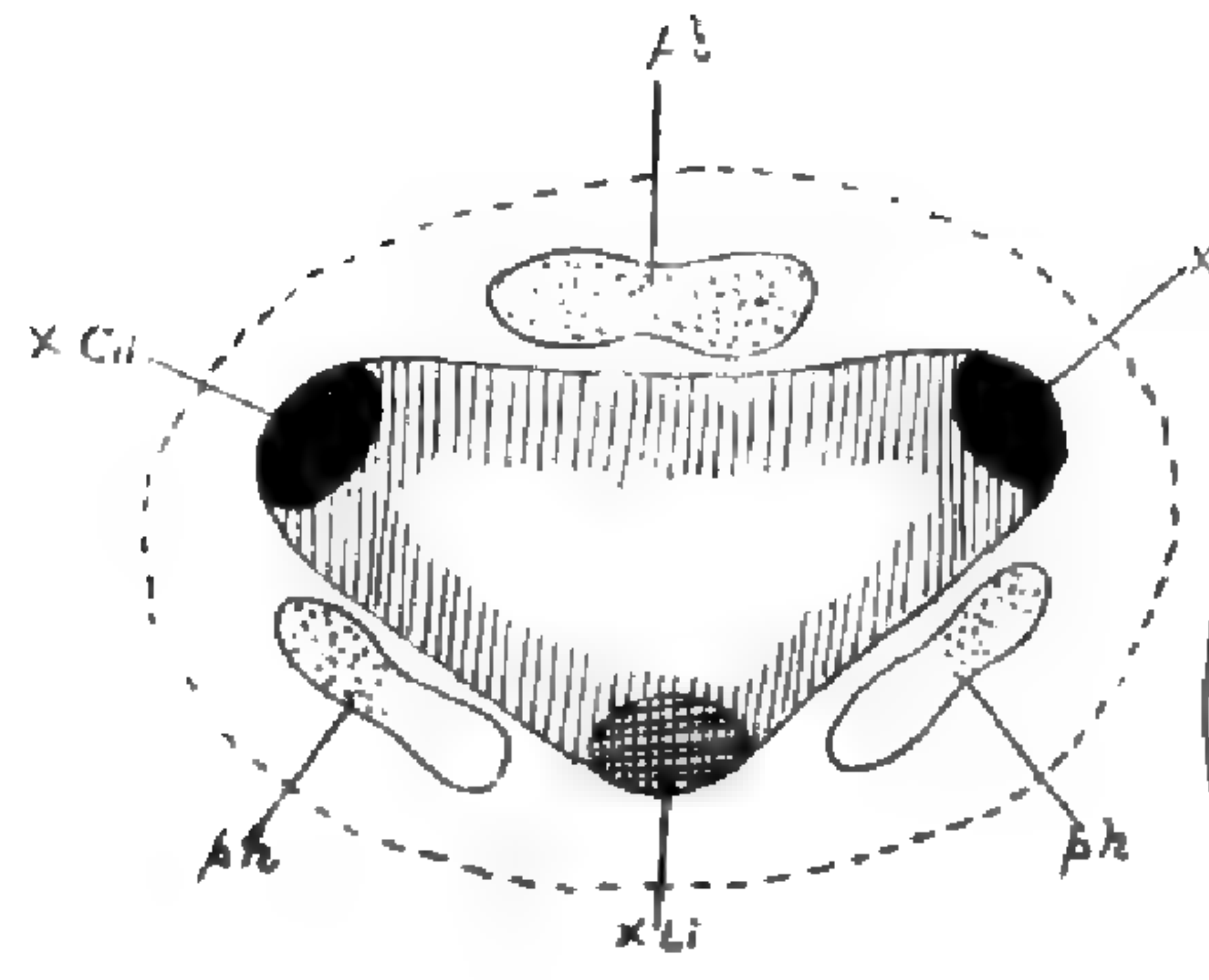

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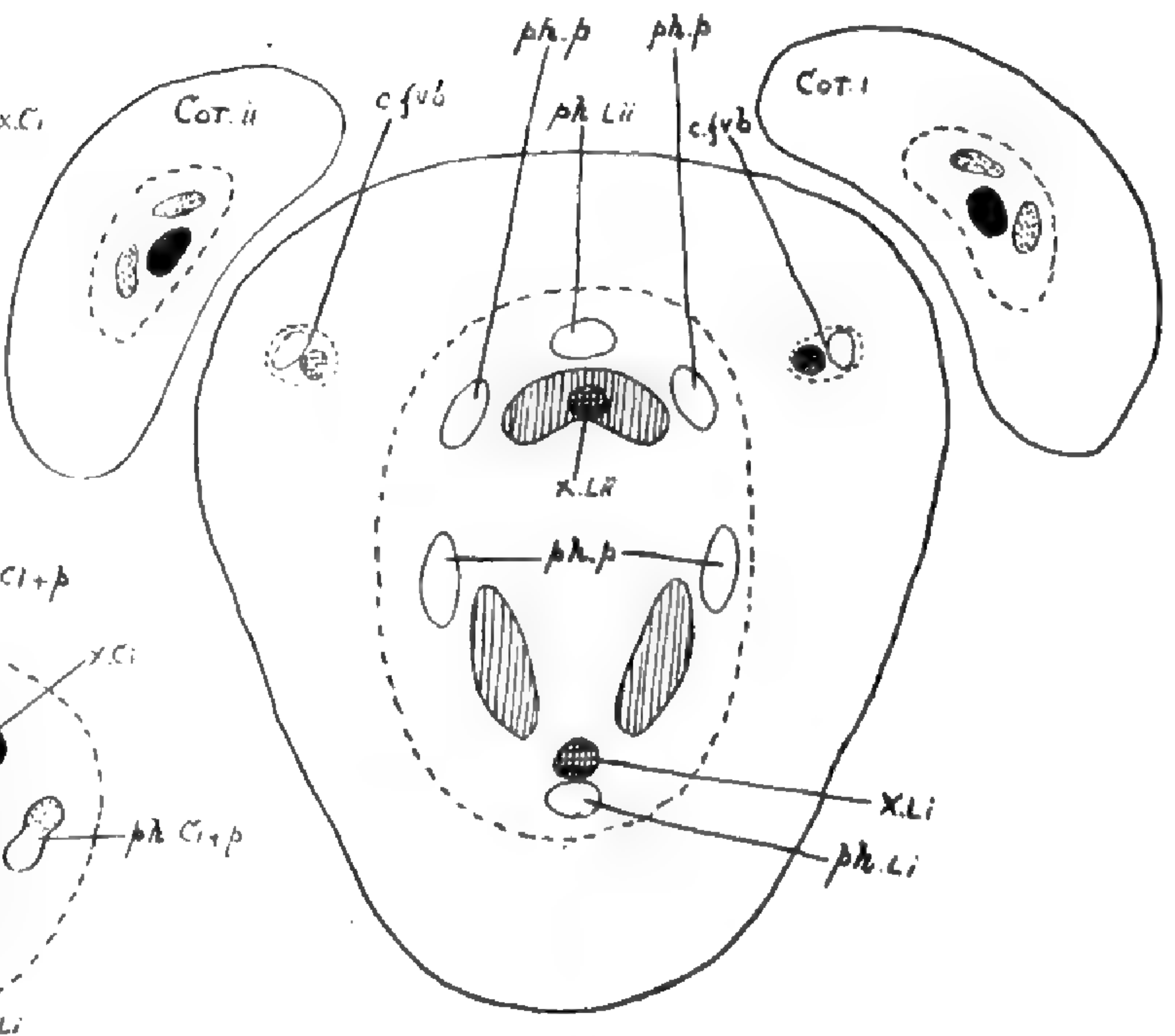

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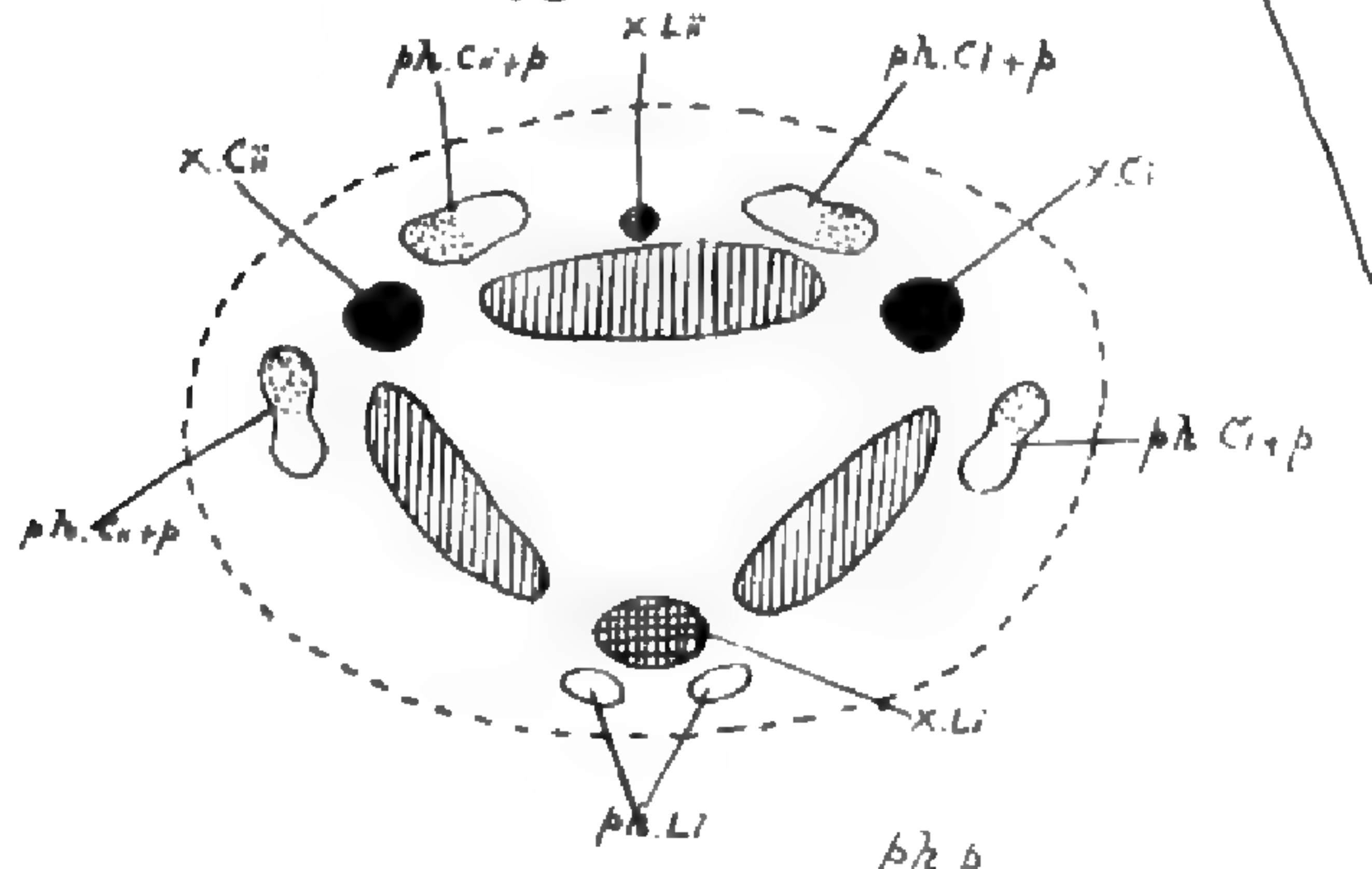

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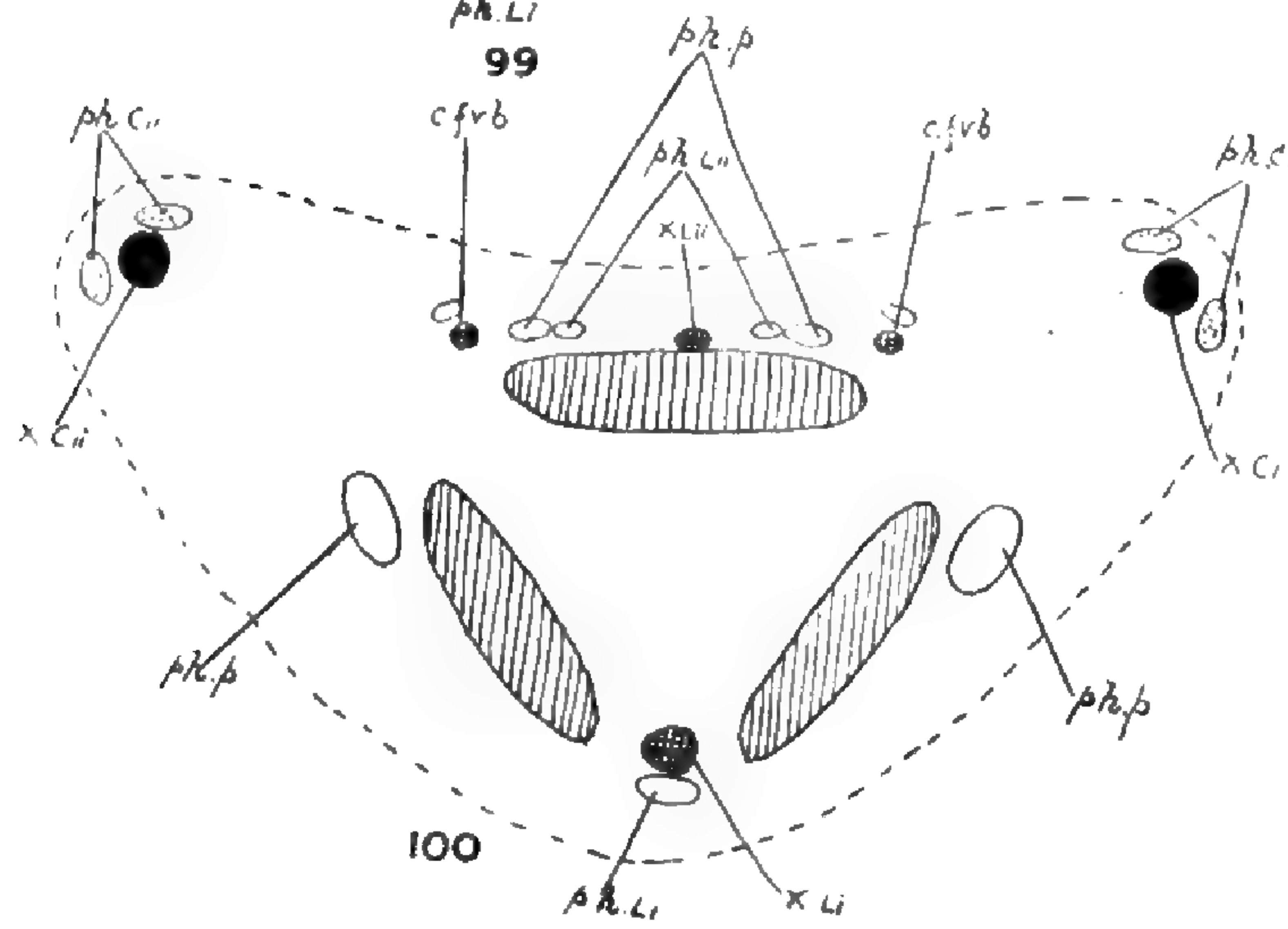

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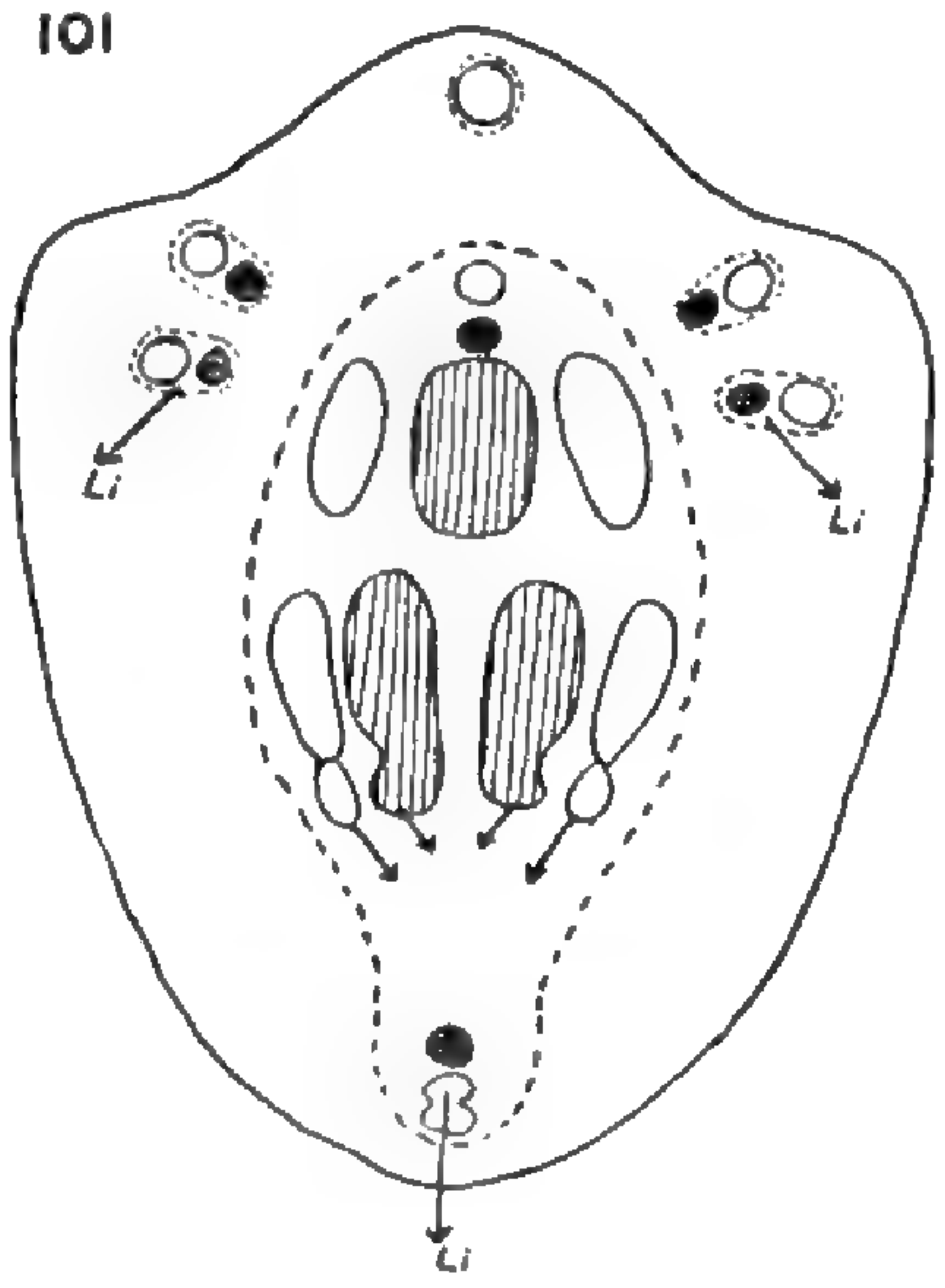

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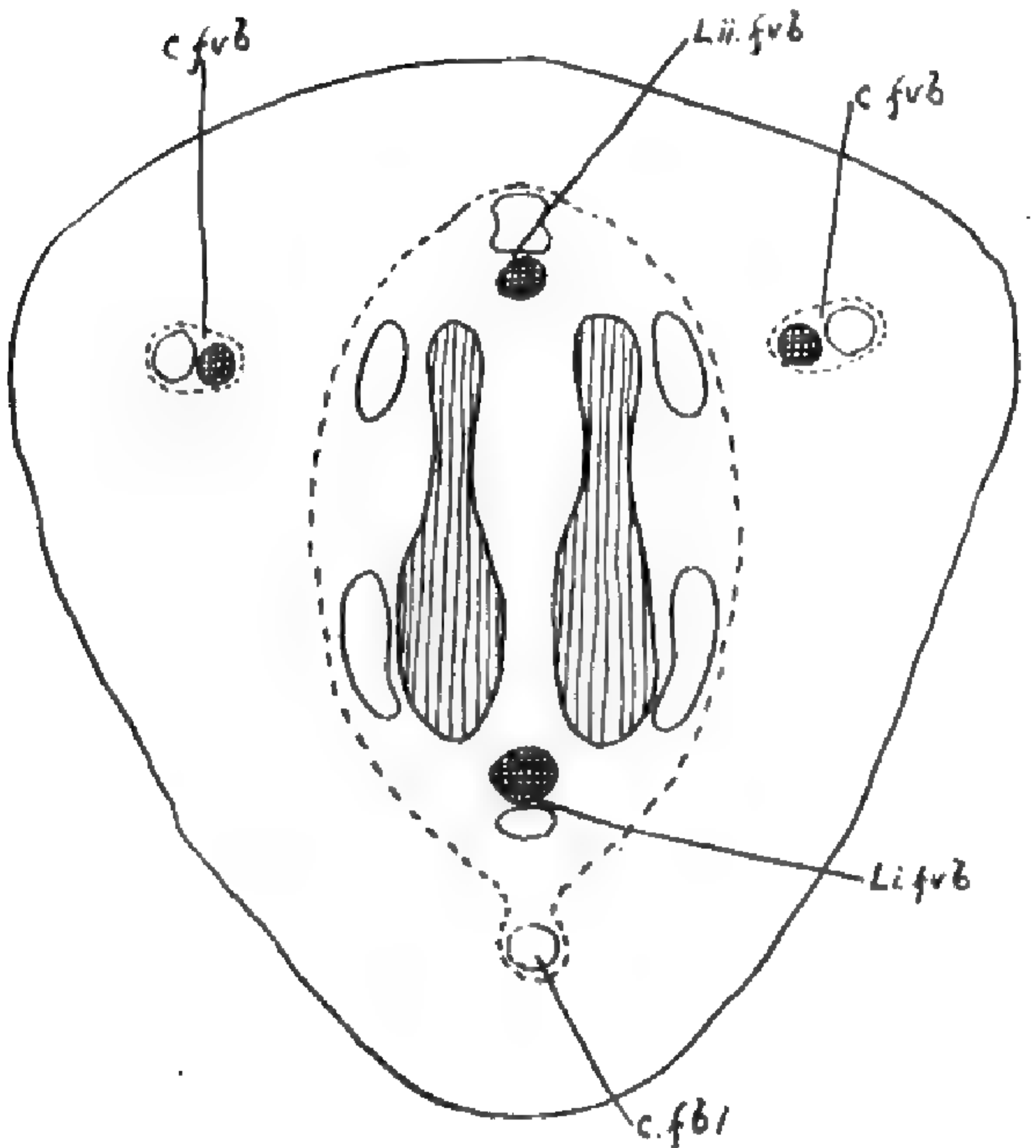

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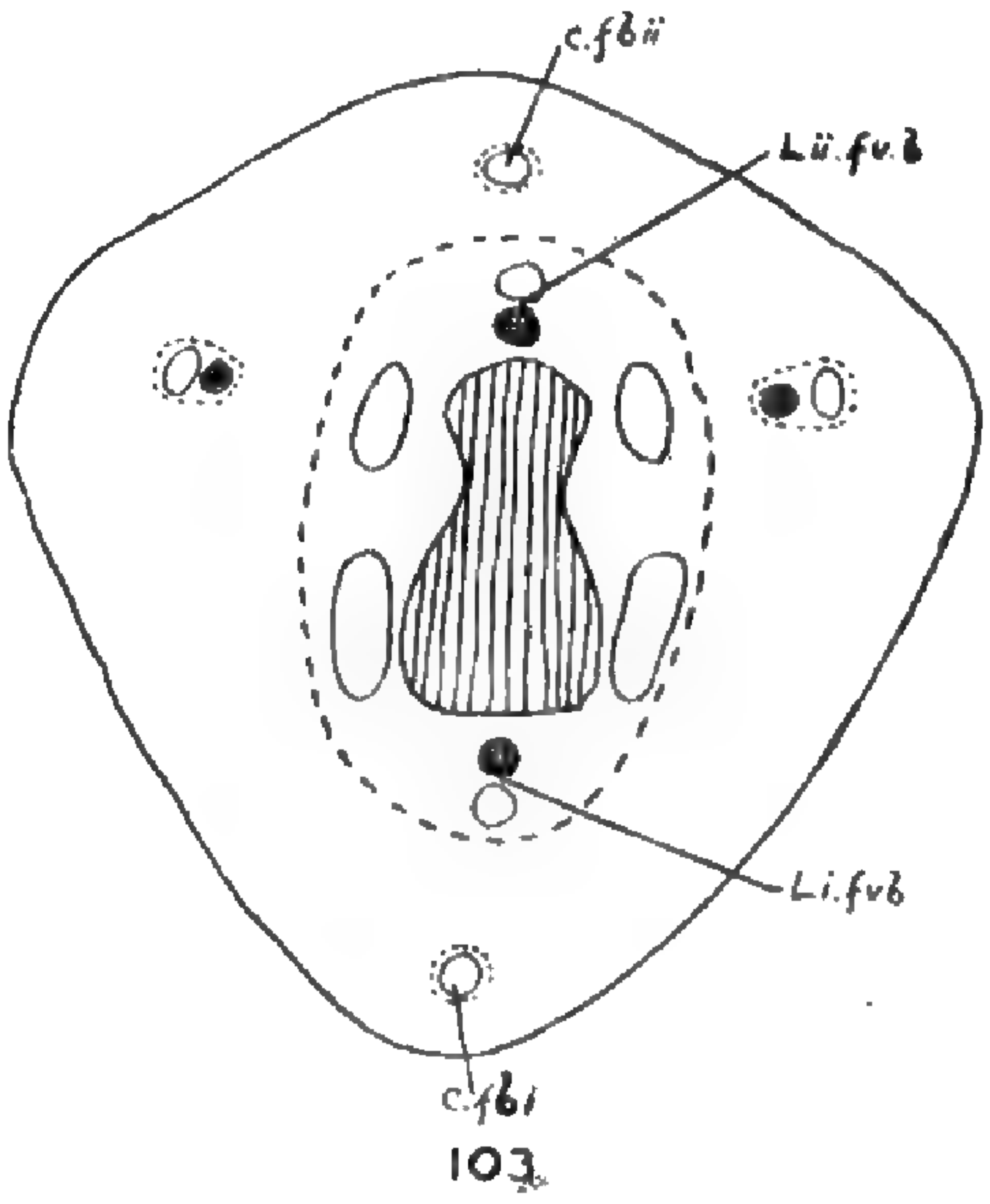

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SEEDLING STRUCTURE IN LEGUMINOSÆ.

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A Revision of the Genus *Millettia*, Wight et Arn. By STEPHEN TROYTE DUNN, B.A., F.L.S., F.R.G.S., sometime Superintendent of the Botanical and Forestry Department, Hongkong, China.

[Read 20th June, 1912.]

MILLETTIA, Wight et Arn. Prodr. 263 (1834) *; Meissn. Pl. Gen. 95 (1836) *; Endl.† Gen. Pl. 1304 (1836) *; Benth. in Miq. Pl. Jungh. 247 (1851–5) *; Miq. Fl. Ned. Ind. i. (1855) 153; Benth. et Hook. f. Gen. Pl. i. (1865) 498 ‡; Baill. Adans. vi. 222; Baker in Oliv. Fl. Trop. Afr. ii. 126 (1871); Baker in Hook. f. Fl. Brit. Ind. ii. (1876) 104; Kurz, For. Fl. Brit. Burm. (1877) 350; Engl. u. Prantl, Pflanzenfam. iii. III. 270 (1894); Prain in Journ. As. Soc. Beng. lxvi. II. 358 (1897); Brandis, Indian Trees, 219 (1906).

Marquartia, Vog. in Nov. Act. Nat. Cur. xix. Suppl. i. (1843) 35, t. 1.

Callerya, Endl. Gen. Suppl. iii. 104 (1843).

Berrebera, Hochst. in Flora, 1846, 597.

Fornasinia, Bertol. Misc. Bot. viii. 18, t. 1 (1849).

Otosema, Benth. in Miq. Pl. Jungh. 248 (1851–5).

Arbores et frutices scandentes vel erecti. *Folia* imparipinnata, 2–multi-juga (rarissime trifoliata vel unifoliata); foliola sæpius subcoriacea, reticulato-penninervia, inderdum stipellata. *Paniculæ* amplæ, angustæ vel ad racemos nodosos reductæ. *Calyx* late campanulatus, dentibus brevibus vel rarius tubo paullo longioribus vel rare obscuris, duobus superioribus sæpe partim vel omnino coalitis. *Petala* sæpe purpurascentia; vexillum ovatum vel orbiculare, patens vel reflexum, sericeum, pubescens vel glabrum, supra unguem intus nudum, callosum vel auriculatum; alæ oblongæ vel rarius ovatæ, basi ut petala carinæ cuneatæ, truncatæ vel hamatæ, carinæ inderdum adhærentes; carinæ petala conformia, obtusa, postice paullo imbricata, cohærentia. *Stamina* sæpissime monadelpha, vexillare basi solutum, interdum autem diadelpha; filamenta apice libera, filiformia; antheræ ovatæ, uniformes. *Discus* breviter cylindricus, annularis vel nullus. *Ovarium* sessile vel rarius stipitatum, lineare, 3–multi-ovulatum; stylus inflexus, teres vel complanatus, apice glaber, stigmate parvo, terminali. *Legumen* lineare vel oblongum, compressum vel crassum, rigide coriaceum vel lignosum, interdum anguste alatum, dehiscens, 2-valve. *Semina* lenticularia, orbiculata vel reniformia, estrophiolata. *Embryonis* radicula sæpius (ubi visa) inflexa, in cotyledonibus accumbens.

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* Excluding the description of the pod as indehiscent.

† Endlicher and a few early authors used the spelling *Milletia*.

‡ Excluding the synonym *Padbruggea*.

The Millettias extend completely across the tropics of the Old World from the west coast of Africa to the Philippine Islands and Australia, and reach beyond them to the south in Africa and Australasia and to the north in the far east of Asia. They vary in habit, like some other large genera of woody *Papilionaceæ*, in conformity with their vast range from small shrubs to large forest trees like *M. caffra*. In tropical Africa some species are extensively grown as shade-trees along the roads, having when in leaf the habit of small Ashes and being covered when in flower with masses of white blossoms. Besides its timber and the ornamental flowers of some species the genus affords few products that are of use to man. Certain species, both in Africa (e. g. *M. ferruginea*) and in Asia (e. g. *M. Piscidia*, *M. macrocarpa*, and *M. ichyochtona*), are known to the native fishermen as possessing in their wood or fruit a substance which has the property of stupefying fish. The stems of the small climbing species are often remarkably tough and are used for the purpose of rough cords by the countrymen of China and other countries. A fibre is prepared from the stems of the common Indian *M. auriculata*, but it is of little commercial value.

GEOGRAPHICAL DISTRIBUTION.—As above stated, *Millettia* is widely distributed over the warmer regions of the Old World. It reaches from Sierra Leone and Abyssinia in north tropical Africa to the temperate regions of the south of that continent. In Asia its area includes Japan, the whole of China proper, Formosa, the Philippines, the western islands of the Malay Archipelago, Indo-China, Siam, the Malay Peninsula, Burma, and the whole of India except the extreme west. It shares its north-eastern regions with the closely allied *Wistaria*, which extends there from North America. In the south-east it merges into and almost encloses the areas of *Fordia*, *Padbruggea*, and *Adinobotrys*, distinguished from it by their fruit, and finally reappears in Australia with the peculiar fruit-characters which characterize the section *Austromillettia*. In its African area it includes the generic regions of *Schefflerodendron*, *Craibia*, *Platysepalum*, and *Dewevrea*, which are indistinguishable from it in general habit, but separable by well-marked peculiarities of foliage or calyx.

HISTORY.

The first species of what is now known as *Millettia* to reach Europe in a botanical collection appears to have been *M. reticulata*, which was gathered by Staunton in 1793[*] in Kwangtung, China, while accompanying Macartney's Embassy to the Emperor of that country, but his specimens remained unidentified until long after the genus had been recognised and built up to a considerable size from other sources. *M. sericea* was, so far as can be discovered, the first species to be described. It was found in Java by La Haye, *Jardinier en chef* in the 'La Pérouse' exploring expedition, and sent by him to Ventenat, who mentioned it as *Pongamia sericea* * when founding that genus in 1803. It was subsequently described by De Candolle (Prodr. ii. 416) in 1825. Two years later a West Tropical African tree (*M. Thonningii*) was described by Schumacher and Thonning (Beskr. Guin. Pl. 349) as *Robinia Thonningii*. In 1832 Roxburgh published the third volume of his 'Flora Indica' and included therein descriptions of four more Millettias, one (*M. Piscidia*) as a *Galedupa*, three (*M. auriculata*, *M. fruticosa*, and *M. racemosa*) as Robinias. The result of subsequent investigations has been to exclude all these species from the genera to which they were originally referred, and to include them one after another in the new genus *Millettia* † founded in 1834 by Wight and Arnott upon the South Indian climbers *M. rubiginosa* and *M. splendens*. In 1835 E. Meyer ‡ described *Virgilia grandis*, which is probably *M. caffra*, from South Africa, and Siebold and Zuccarini from the extreme opposite end of the generic range *Wistaria japonica* §, now also regarded as a *Millettia*. Even eight years later when the next species was detected, this time in South China, the character of *Millettia* was so little appreciated by Vogel that he founded upon it the new genus *Marquartia*. To Meissner ‖ belongs the credit for making the first addition to Wight and Arnott's genus by referring to it a hardwood tree of South Africa which he called *M. caffra*, thus preparing the way for the recognition of the wide range of the genus. But in 1843 a third new genus (*Berrebera*) was based on an Abyssinian *Millettia* (*M. ferruginea*) by Hochstetter. In 1849 Hooker added a fourth to the three species already recognised as *Millettia* by describing *M. macrophylla* from Nigeria ¶. At the same time he reduced Hochstetter's species to the same genus. Here for the first time was recognised the truly dehiscent character of the pods of the genus. Wight and Arnott, dealing with a species (only one was known to them in fruit) with tardily dehiscent pods, and guided probably by pod specimens which, though apparently ripe, had not yet opened, described them as indehiscent. Hooker described another *Millettia* from the same region in the same work, but in the absence of fruit referred it with doubt to *Lonchocarpus*.

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[*] The actual specimen is in the British Museum Herbarium.

A few years later Junghuhn's Malayan *Leguminosæ* were submitted to Bentham for determination and among them fine specimens of *Millettia sericea*. Of this species, which had already been briefly diagnosed by

---

* Ventenat, Malm. 28.

† After Dr. Millett, of Canton.

‡ E. Meyer, Comm. 1.

§ Siebold et Zuccarini, Fl. Jap. i. 88.

‖ Meissner in Lond. Journ. Bot. ii. (1842) 99.

¶ Hooker, Nig. Fl. 318 (1849).

De Candolle under the name of *Pongamia sericea,* Bentham gave a full description and in a long note reviewed the whole group of genera which were liable to be confused with these two. One of these, *Otosema*, has now been reduced to *Millettia*, and with it a new species, *O. caudata*, described on this occasion. Under *Millettia* 17 species were enumerated, including, besides those already mentioned, 2 new ones and 2 reductions. Twelve of these 17 are still retained.

During the seventies Baker wrote his descriptions of all the Millettias then known from Tropical Africa and India in the two great Floras of these regions in preparation at Kew at that time. To the two already described from Tropical Africa were added five from Welwitsch's Angolan sets and four more from other sources. For India 24 were enumerated, including seven recently described from Burmese material by Kurz. With these 34 and the 4 already described from China the strength of the genus was thus raised to 38, 33 of which are still retained. The Chinese species amounted to six by the time Hemsley published the *Leguminosæ* of his 'Enumeration' in 1884. Since that time the botanical exploration of Tropical Africa, pushed rapidly forward by British, French, German, and Belgian collectors (but made effective by publication of the results chiefly by the two latter), has brought to light a large number of new species, of which Harms has published fourteen, mostly from the German colonies, and De Wildeman twelve from the Congo region, while 25 * are added in this paper, three being reduced from other genera. The number of African Millettias thus stands now at 71.

The most important recent contribution to our knowledge of the genus in Asia has been Prain's review of the Indian species in the 15th part of his "Novitiæ Indicæ" †, where eight species are described. Collett and Hemsley described three from the collections of the former in the Shan Hills. Seven more are described for the first time in this paper, making the Indian *Millettia* list after some necessary reductions up to 34. Chinese Millettias with the addition of five in this paper amount to 14.

With 9 species from the Philippine Islands and a few from other countries not mentioned above the total number of the genus as now known amounts to 138.

Such is the history of the genus as it now stands. It is only necessary further to explain the absence of a number of species previously included, but recognised as aberrant from the average types of *Millettia*. Soon after the commencement of this revision it was realized that the genus as it then stood had become so heterogeneous and ill-defined that it would be necessary to reduce groups of species to other genera and even in some cases to make new genera in order to restore it to manageable systematic limits. Thus *Craibia* [*] was established to accommodate a group of African species with alternate leaflets, *Adinobotrys* [†] certain Indo-Malayan trees and climbers with indehiscent pods. *Padbruggea* [‡] was reinstated for a somewhat similar group. *Fordia* [§] was enlarged to receive a number of shrubs with 2-ovuled pistils.

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* For a preliminary account of these, see Dunn in Journ. Bot. xlix. (1911) 221.

† Prain in Journ. As. Soc. Beng. lxvi. II. (1897) 358–365.

These investigations also led to the establishment of *Leptoderris* [||] and *Ostryoderris* [¶] and to the extension of *Ostryocarpus* [**], not because these genera were nearly allied to *Millettia*, from which their *Derris*-like fruit at once distinguished them, but because, in the absence of fruit, many species properly belonging to them had been included in *Millettia* and had in this revision to be placed elsewhere.

A large number of *Millettia* species have been given names under *Phaseolodes*, Mill. by Otto Kuntze [††], and under *Kraunhia*, Raf. by Prain [‡‡] (Indian spp.) and by Greene [§§] (chiefly Australian spp.), on the assumption of their congeneric relations with *Wistaria*, which is antedated by the two latter. The view adopted by the writer that *Millettia* and *Wistaria* are distinct in consequence of their inflorescence renders the citation of the synonymy thus introduced unnecessary in this paper, but the *Kraunhia* and *Phaseolodes* combinations already published may be found by reference to the books mentioned.

Systematic Position.

The Leguminosæ which have woody stems, unequally pinnate leaves, papilionaceous flowers, and coherent stamens were collected by Bentham and Hooker in their 'Genera Plantarum' into two tribes, *Galegeæ* and *Dalbergieæ*, according to the dehiscence or indehiscence of their pods; and although there are certain genera possessing the above characters which cannot for other reasons be included and *vice versâ*, botanists are generally agreed that these tribes represent a natural division of the family. In the same way, the fact that some genera of *Galegeæ* possess pods which do not open at maturity, but are nevertheless otherwise clearly referable to that tribe, does not affect the usefulness of Bentham's diagnostic character. The *Galegeæ* were again divided into 7 sub-tribes, 5 of which were based principally upon special single characters, leaving *Tephrosieæ* and *Robinieæ* to divide between them the typical elements of the tribe. They are not in fact, themselves very readily divided and are distinguishable rather by tendencies than by characters. It will be sufficient, however, here to note that the only *Robinieæ* inhabiting the same regions of the world as *Millettia* (i.e. *Microcharis* and *Sesbania*) are easily and naturally distinguished by obvious generic characters, while the American and therefore geographically extra-Millettian genera *Robinia* and *Gliricidia* show close connection with that genus. *Robinia* has, however, a tendency to be thorny or bristly, which is never observed in *Millettia*, while *Gliricidia* differs from all known Millettias in its strictly racemose and axillary inflorescence *.

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[*] Dunn in Journ. Bot. xlix. (1911) 106.

[†] Dunn in Kew Bull. 1911, 194.

[‡] Dunn, *l. c.* 197.

[§] Dunn, *l. c.* 63.

[||] Dunn, *l. c.* 1910, 386.

[¶] Dunn in Kew Bull. 1911, 363.

[**] Dunn, *l. c.* 362.

[††] Kuntze, Rev. Gen. Pl. i. 201.

[‡‡] Prain in Journ. As. Soc. Beng. lxvi. II. (1897) 358.

[§§] Greene in 'Pittonia,' ii. 175.

Millettia, then, is placed among the *Tephrosieæ*. There is only one other large genus in that sub-tribe containing, like *Millettia*, trees and shrubs, i.e. *Tephrosia*, and that is readily distinguishable by the regular development of the long row of ovules in its ovary into a continuous even series of small seeds enclosed in the narrow, linear, thin-valved pod. There are, however, 8 smaller genera which closely resemble *Millettia* in habit and floral structure. They should be placed near it in the sub-tribe. All but one have been described since the appearance of the *Leguminosæ* in the 'Genera Plantarum.' Their interpolation with the genera there described is suggested as below :—

Number in 'Genera Plantarum.'	Suggested inter-polation.	Name of genus and place of publication.
102	..	Mundulea, *DC. Mém. Lég.* 266.
103	..	Sarcodum, *Lour. Fl. Cochinch.* 461.
..	103-1	Schefflerodendron, *Harms in Eng. Jahrb.* xxx. (1901) 87.
..	103-2	Craibia, *Harms and Dunn in Journ. Bot.* xlix. (1911) 107.
104	..	Millettia, *Wight et Arn. Prodr.* 263.
..	104-1	Platysepalum, *Welw. ex Baker in Oliver, Fl. Trop. Afr.* ii. 131.
..	104-2	Dewevrea, *M. Micheli in Bull. Soc. Bot. Belge*, xxxvii. (1898) I. 47.
..	104-3	Fordia, *Hemsl. in Journ. Linn. Soc., Bot.* xxiii. (1886) 160.
..	104-4	Adinobotrys, *Dunn in Kew Bull.* 1911, 194.
..	104-5	Padbruggea, *Miq.*; *Dunn, l. c.* 197.
105	..	Wistaria, *Nutt. Gen. N. Am. Pl.* ii. 115.

KEY TO ABOVE GENERA †.

1.	Flowers in terminal racemes or axillary fascicles ‡	2
	Flowers in panicles or in axillary or lateral racemes	3
2.	Erect shrubs	*Mundulea.*
	Climbing shrubs with terminal racemes	*Wistaria* §.

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* See account of inflorescence below.

† *Sarcodum*, an imperfectly known genus from Indo-China, is omitted.

‡ *Fordia pauciflora*, Dunn (*Millettia cauliflora*, Prain), has solitary or fascicled flowers.

§ Confined to *W. frutescens*, *W. brachybotrys*, and *W. chinensis*.

3.	Leaflets alternate *	4
	Leaflets opposite †	5
4.	Leaflets and petals glandular	*Schefflerodendron.*
	Plants eglandular	*Craibia.*
5.	Pod with one or few very large seeds, always (?) indehiscent	6
	Pod dehiscent	7
6.	Inflorescence lax	*Padbruggea.*
	Inflorescence crowded	*Adinobotrys.*
7.	Ovary 2-ovuled, pod 2-seeded	*Fordia.*
	Ovary many-ovuled	8
8.	Calyx with 4–5 nearly equal teeth or truncate	*Millettia.*
	Calyx lobes 2 or very unequal	9
9.	Calyx 2-lobed	*Dewevrea.*
	Calyx with one lobe much larger than others	*Platysepalum.*

MORPHOLOGY.

Stem.—The habit, as has already been said, varies to a considerable extent, and the degrees of arborescence or dependence upon the support of stronger plants are nearly always associated with corresponding peculiarities of the leaves or flowers. It thus happens that several of the sections, all of which are founded principally upon the characters of the latter organs, consist of plants of similar habit. Thus the *Afroscandentes* are all climbers, the *Sericanthæ* are all erect. The arborescent species are mostly of small or medium stature, though a few fine timber-trees occur among them.

The climbers vary from large and heavy lianes, such as *M. auriculata* of the tropical forests of India, to the small slender creepers which adorn the hedges and wood-borders of China and Japan. In several observed cases these climbers emit leafless, whip-like shoots, often many yards in length, which trail along the ground or work their way up trees by means of reflexed hairs, stipules, or bent petioles.

Buds.—One section of the genus, viz. *Compresso-gemmatæ*, is peculiar in having its leaf-buds flattened tangentially to the stem, the bud-scales being narrowly boat-shaped and each hooked in turn over the opposite lower one by their hooded tops, or in one species (*M. caffra*) the outer scale being completely wrapped round the others, keeled at both sides, and opening down the inner face.

Leaves.—Most of the species are evergreen, but in a large number, such as *M. Thonningii*, the leaves fall just before the flowers are produced, the tree remaining leafless for a few weeks during the flowering period. Others, in regions with a cold or dry season, are bare for a longer period. The stipules are seldom persistent and are usually narrow and pointed, but in some cases they remain up to or even after the fall of the leaf. In *M. micans* they are large, blunt, and peltately attached near the base. The leaflets, varying greatly in number, shape, size, and pubescence, provide the greatest evidence of specific difference and are widely used for the superficial discrimination of Millettias. The hairs are always simple. In the *Efulgentes* and a few other groups they become flattened and scale-like on the lower surface of the leaflets, giving them a fine metallic silver or golden lustre.

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* One African species has simple leaves.

† One species from the Malay Peninsula has simple leaves.

The stipels, if present at all, are, in all cases known, persistent up to maturity and have proved a valuable guide to the divisions into which the genus naturally falls.

Inflorescence.—True racemes, in the simplest sense of the word—*i. e.*, single peduncles bearing pedicels scattered singly along their length,—do not occur in *Millettia* as here defined. No species has been included in the genus which has solitary racemes terminating a leafy shoot nor in the axils of a shoot terminating in leaves. This is the most effective distinction that I am able to discover between *Wistaria* (restricted as above) and *Millettia*, and also between the American *Gliricidia* and *Millettia*. Some species of the latter genus bear their flowers in nearly simple racemes, but in these all the minute nodes are two- or more-flowered. The Philippine *Fragilifloræ* contain many such species, and similar ones occur in the African *Sericanthæ*. At the next step away from the simple raceme, fascicles of flowers occur on sessile globular nodes, as in the *Afroscandentes* in Africa and the *Typicæ* in India. The above forms of inflorescence are generally (as in the diagnoses below) called racemes, because no branching in a general sense occurs. When the nodes become a little lengthened, so that the flowers are crowded upon a cylindric spur (*ramulus floriferus*), as in most of the *Efulgentes*, or at the top of a short peduncle, as in *M. Brandisiana*, the inflorescence is really paniculate, though little different in appearance from a raceme. It may then be called *panicula racemiformis*. When the branchlets are still further elongated and more similar to the panicle rachis, the flowers become more spaced and form panicles in the general sense, sometimes long and narrow as in *M. leptobotrya*, sometimes broad and spreading as in the *Eurybotryæ*.

Flower.—The calyx is usually five-toothed and stiffened on the upper side by the coalescence of the two anterior teeth nearly to the top. In the notch thus formed the standard rests at about the top of the claw, while the blade is strongly reflexed over the top of it as the flower fully opens. This ensures the maintenance of the standard base in close proximity to the bases of the lower petals and to the staminal sheath, which is essential for the proper working of the floral mechanism, if I rightly understand it, during pollination. In the *Fragilifloræ* and some other sections the calyx is wide and soon leaves the petals quite free. The bracteoles which enclose the young flower-bud are usually deciduous, but they persist in some sections at the base of the calyx or a little below it on the pedicel. In the *Efulgentes* they are usually large and wide, and persist during flowering-time; in some of the *Sericanthæ* they are of unusual length, sometimes overtopping the flower. The pedicel varies in length from twice the calyx down to very small dimensions in the subsessile flowers of some *Albifloræ* and allied sections.

The clothing of the petals is usually constant through sections. Many sections have petals with beautifully coloured, adpressed, silky pubescence, while in others, such as the *Truncaticalyces*, they are quite glabrous. But of all the parts of the flower it is the base of the standard which gives the best superficial indication of the sectional grouping of the genus. The special modifications of this organ are probably concerned in the opening and closing of the nectar-producing region round the base of the ovary when the flower is visited and pollinated by insects. In all the Millettias this cavity is enclosed by the base of the staminal sheath. It is, however, always accessible on the upper side in consequence of the upper or vexillary stamen being quite free or, more usually, free at the base only from the others, which, moreover, gape open a little on both sides of it. Where this stamen does not itself close the aperture while the flower is undisturbed, the bases of the wing and keel petals perform the same protective function, and it is, I conjecture, for the proper opening and closing of the nectary space, and for the leading of the visiting insect into the best position for pollination during its search for honey, that the numerous remarkable modifications of the staminal sheath and the petal bases occur.

It is, of course, as in other Papilionaceæ, necessary for cross-fertilization that an insect alighting on the flower for the purpose of obtaining the nectar should press down by its weight the elastic wing and keel petals, until its body comes into contact with the comparatively stiff stamens and the pistil which lies concealed among them. When the nectary space is closed by the upper stamen, the latter is sometimes grasped by two callous projections at the base of the standard or enfolded by the whole length of its claw, so that the least depression of the staminal sheath by the weight, for instance, of an insect resting on it, draws it away from the upper stamen so held and opens a way to the nectar. In cases where the openings are normally closed by the wings and keel or by projections from their bases (as when they are hooked), there are various devices for holding these petals together in such a way that an insect visitor will open them. Sometimes their upper edges are held together in a notch of the standard so shallow that the least pressure disengages them from it and causes them to slide apart over the smooth staminal cylinder until the nectarian openings are disclosed. This notch is usually formed by callous thickenings of the standard base or by the infolding of its margin into stiff auricles. Where both wings and keel cover the openings and it is necessary that they should both be pressed down together, their coherence is secured by a fold of the keel petals fitting into a pocket in the wings usually halfway down their length and near their upper edge. Another means of holding the interior petals together is secured by the curious device, which obtains throughout the *Efulgentes*, in which delicate projections at the bases of these petals are hooked into the upturned auricles of the base of the standard.

The staminal whorl, as has been said, is either monadelphous in this genus with the vexillary stamen free at the base* or diadelphous, the nine lower stamens being united by their filaments into a sheath, the upper one quite free. The cohesion of the stamens is nearly always constantly either diadelphous or monadelphous at anthesis throughout each section. The character was much used by the earlier botanists in discriminating genera, but, in *Millettia* at least, it is not found useful to rely upon it, as it is not easy to ascertain whether the vexillary stamen is permanently attached to the rest or free at complete maturity. The vexillary stamen seems always to be inserted a little within the others, and where they are separated from the base of the ovary by a perceptible space is sometimes continued down to its base by a raised rib or line. Its lower extremity is usually broadly winged so as to close the very base of the staminal sheath, and the wing then overlaps the neighbouring portions of the sheath, being outside it on one side, inside on the other. In not a few species the petals are coherent with the sheath at its base, though free from the calyx, so that the wings and keel appear to be inserted on the sheath while the vexillary stamen is adherent to the base of the claw of the standard.

A disc is frequently present. In many sections, especially in those having stalked ovaries, it is a short fleshy tube closely investing the stalk or the lower part of the ovary. It may be truncate or oblique or lobed, or may be reduced to a ring. In some of the African sections it is adnate to the lower part of the calyx-tube, appearing as a plane or lobed rim at the base of the perigynous stamens. In the *Efulgentes* the adnate part is longitudinally ribbed, the ribs running out at the top into a fringe of blunt linear lobes.

The ovary is linear, containing from three to many ovules and ending in a curved, usually glabrous, and sometimes flattened style and a glabrous capitate stigma.

The pod, in the great majority of cases, is elastically dehiscent into two valves at maturity, but in some species the dehiscence is so much delayed that the impression is given that no natural opening occurs along the sutures, as in the case of the species upon which the genus was founded by Wight and Arnott, who described it as having indehiscent pods. In a few species, such as *M. sericea*, the dorsal suture does not usually open, and in a few others, such as *M. pachycarpa*, the valves are apparently soft and leathery at maturity and do not separate until the fruit dries up, but otherwise the whole genus is remarkably constant in the elastic woody nature of the pod valves and in their prompt dehiscence.

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* The vexillary stamen in that case usually becomes quite free as maturity is passed, and this may aid cross-fertilization, because the weight of the insect will rest on the anthers while the sheath is closed, but later when the sheath is split along the top the insect will push it down with the petals until its body rests on the stigma.

MATERIAL.

With the exception of one or two visits to other Herbaria the whole of the following revision has, by the courtesy of the Director of the Royal Botanic Gardens, Kew, been elaborated in the pleasant and convenient surroundings of the Herbarium and Library of that great establishment, and the specimens which form the foundation of the work will be mostly found there.

Sir David Prain's work upon the Indian Millettias and his notes upon them (Journ. As. Soc. Beng. lxvi. ii. 360 etc.) have left little more to be done in that field, but, as an additional assistance, he did me the great favour to borrow and Major Gage to lend the whole material of the genus from the Calcutta Herbarium, more than 800 sheets of splendid specimens, mostly arranged and annotated by him.

Besides these a large mass of types and critical specimens has been borrowed, with the kind help of Dr. Stapf, from other European herbaria. Thus it was possible to study at leisure at Kew 200 sheets of African material which Dr. Harms, with the leave of Prof. Engler, was good enough to select from the Berlin Herbarium. I have also to thank Dr. Harms for the valuable notes with which, from his unique knowledge of African Leguminosæ, he was able to supply me.

At the beginning of 1911 I had the privilege of studying the Millettias in the Paris Herbarium and of receiving much valuable information from M. Gagnepain, M. Pellegrin, and Père Sacleux, and afterwards from M. Chevalier regarding Asiatic and African species.

My thanks are due to Dr. Rendle, Keeper of the Botanical Department of the British Museum, for allowing free access to the invaluable collections under his charge and for lending 103 critical specimens for comparison at Kew.

In the subjoined list these and other loans of specimens are enumerated, and I wish here to record my thanks to the gentlemen mentioned for their great kindness in thus assisting me.

Sender.	*Herbarium.*	*Material.*
H. Harms.	Berlin.	200 sheets, chiefly African.
H. Lecomte.	Paris.	75 sheets, chiefly African.
E. De Wildeman.	Brussels.	15 Congo types.
H. Hallier.	Leiden.	213 sheets, mostly Malayan.
F. Went.	Utrecht.	9 sheets, Malayan.
A. T. Gage.	Calcutta.	800 sheets, Indian.
A. Chevalier.	His own.	50 sheets, W. African.
A. B. Rendle.	British Museum.	103 sheets, African.
W. J. Tutcher.	Hongkong.	72 sheets, Chinese.
E. D. Merrill.	Manila.	Set of Philippine material.
J. Bonati.	His own.	2 of Pampanini's types.
J. S. Gamble.	His own.	Indian species.
I. H. Burkill.	Herb. R. E. P. Calcutta.	Economic species.

Advantage was taken of the collection together of so fine a series of authentic *Millettia* material by dissecting and drawing flowers of all the species and drawing up the descriptions which will be found below with citation of the specimens examined.

SECTIONS.

No. of Section.	Name of Section.	Stipellæ.		Standard.		Petals.		Other distinguishing characters.
		Present.	Absent.	Auriculate.	Exauriculate.	Hairy.	Glabrous.	
1	Typicæ	×	..	..	×	×	..	Pedicels fascicled.
2	Eurybotryæ	×	..	..	×	(6)	(6)	Pedicels single.
2 A	Austro-millettia	×	..	×	..	×	..	Pod woody, terete.
3	Bracteatæ	×	..	..	×	..	×	Bracts exceeding flowers.
4	Podocarpæ	..	×	..	×	..	×	Ovary stipitate.
5	Macrospermæ	..	×	..	×	× (7)	..	Seeds thick, oval.
6	Fragilifloræ	..	×	× (9)	..	..	× (8)	Pedicels slender.
7	Otosema	×	..	×	..	×	..	Pedicels clustered.
8	Albifloræ	..	×	×	(1)	..	×	Petals white, glabrous.
9	Efulgentes	× (2)	..	×	..	..	×	Petals white, glabrous.
10	Compresso-gemmatæ	×	..	×	..	×	..	Buds compressed.
11	Afroscandentes	× (3)	..	..	×	×	..	West African climbers.
12	Truncaticalyces	..	×	..	×	..	×	Calyx truncate.
13	Sericanthæ	(4)	(4)	..	×	×	..	Chiefly E. African shrubs.
14	Polyphyllæ	× (5)	..	..	×	×	..	Leaflets numerous, oblong.
15	Robustifloræ	×	..	..	×	×	..	Stamens protruded.

(1) One is exauriculate.
(2) A few exstipellate.
(3) *M. Barteri* and *M. calabarica* have no stipellæ.
(4) Some stipellate, some exstipellate.
(5) *M. lenneoides* has no stipellæ.
(6) Two well-marked divisions having glabrous and hairy petals respectively.
(7) Except *M. pachycarpa*.
(8) Or sometimes slightly pubescent.
(9) Except *M. stipulata* and *M. littoralis*, in which the standard is folded, but not callous at the base.

1. TYPICÆ, *Dunn*, sect. nov. Arbores et frutices erecti vel scandentes. Foliola stipellata. Racemi sæpe axillares. Flores in nodis fasciculati. Vexillum exauriculatum, dorso sericeum. Stamina sæpius monadelpha, vexillare basi solutum. Discus nullus. Ovula sæpius 3–6.

Distributed chiefly over Burma, Siam, and E. China. *M. pulchra* extends to N.E. India and *M. rubiginosa* and *M. splendens* are confined to the S. of India. 9 spp., n. 1–11.

It is connected with the rest of the genus through the *Eurybotryæ*.

2. EURYBOTRYÆ, *Dunn*, sect. nov. Frutices scandentes vel rarius vagantes. Foliola stipellata. Paniculæ sæpius terminales, latæ. Flores singuli, in racemos longos divergentes dispositi. Petala glabra vel sericea; vexillum exauriculatum. Stamina diadelpha. Discus sæpissime prominens, cylindricus. Ovarium basi sæpius attenuatum. Legumen sæpius compressum.

Extends over Mid and South China, Upper Burma, and Tonkin, with *M. japonica* in Japan and *M. cinerea* in N.E. India. 12 spp., n. 12–23.

In its inflorescence it is allied to the *Bracteatæ* and through *M. japonica* with *Wistaria*, the large-seeded *M. cinerea* connects it with the *Macrospermæ*, and *M. Dorwardi* and *M. sericosema* having obscurely auriculate standards form a transition to the sections with that character fully developed.

2 A. AUSTRO-MILLETTIA, *Dunn*, sect. nov. Frutices sæpissime scandentes. Foliola stipellata. Paniculæ terminales. Flores singuli, in racemos divergentes dispositi. Petala sericea; vexillum auriculatum. Stamina diadelpha. Discus nullus. Legumen crassum, lignosum.

Confined to Australasia, occurring only in Queensland, Northern New South Wales, and in Norfolk Island. Spp. 3, n. 23 *a*–23 *c*.

Its affinity is with the *Eurybotryæ*, from which it differs in its auriculate standard and thick woody pods.

3. BRACTEATÆ, *Dunn*, sect. nov. Frutices scandentes. Foliola stipellata. Paniculæ terminales. Flores singuli, in racemos longos dispositi, longe bracteati. Petala glabra; vexillum exauriculatum. Stamina diadelpha. Discus tubularis. Ovarium stipitatum. Legumen longum, glabrum; endocarpum separabile, papyraceum.

S. India to Philippines. Sp. 1, n. 24.

Allied closely with the *Eurybotryæ*, but distinguished from it as from all other Millettias by its pod.

4. PODOCARPÆ, *Dunn*, sect. nov. Arbores. Foliola exstipellata. Racemi axillares. Flores singuli vel bini. Petala glabra; vexillum exauriculatum. Stamina sæpius diadelpha. Discus sæpius tubularis. Ovarium stipitatum.

Distributed over U. Burma, Tonkin, and S. China, only *M. Piscidia* extending into Bengal and Assam. Spp. 5, n. 25–29.

M. Bonatiana differs in several respects from the above sectional diagnosis. It forms a link with *Wistaria* and *Gliricidia*.

5. MACROSPERMÆ, *Dunn*, sect. nov. Frutices scandentes. Foliola exstipellata. Paniculæ racemiformes vel racemi axillares vel laterales. Flores fasciculati. Petala sæpius sericea; vexillum exauriculatum. Stamina monadelpha. Discus parvus vel sæpius nullus. Legumen turgidum. Semina crassa.

From E. India to Siam, Java and S. China. Spp. 4, n. 30–33.

Allied to the *Eurybotryæ* as indicated above.

6. FRAGILIFLORÆ, *Dunn*, sect. nov. Arbores deciduæ, sæpius magnæ. Foliola exstipellata. Racemi axillares. Flores fasciculati, fragiles. Calyx sæpius tandem explanatus. Petala glabra vel sparse pubescentia, tenera; vexillum sæpissime fortiter callosum. Stamina monadelpha, vexillare basi solutum. Discus nullus. Ovarium pauci-ovulatum.

One half of the section inhabits Burma, Siam, and the Malay Peninsula, with one species in Sikkim and one in Java; the other half is Philippine. Spp. 19, n. 34–52.

The callus at the base of the standard is very uniform and characteristic of the section. It may be explained as an S-shaped ridge connecting the edge of the claw below with the margin of the blade above.

It is rather an isolated and naturally compact section, with a tendency towards *Otosema*, but no intermediates. *M. decipiens* closely resembles *Pongamia glabra*. Prain's notes on the group in Journ. As. Soc. Beng. lxvi. II. 362 (1897) should be read.

7. OTOSEMA, *Benth. in Miq. Pl. Jungh.* 248. Arbores vel frutices scandentes. Foliola stipellata. Paniculæ racemiformes vel racemi sæpe axillares vel laterales. Flores fasciculati. Petala sericea. Vexillum auriculatum. Stamina sæpius monadelpha, vexillare basi solutum.

The section is divided into a group of climbers distributed chiefly from N.W. India to Lower Burma and a group of trees from Burma to Tonkin and S. China. Spp. 10, n. 53–60.

It is connected with the next section through the white- and glabrous-petaled *M. pendula*.

8. ALBIFLORÆ, *Dunn*, sect. nov. Arbores. Foliola exstipellata. Paniculæ axillares et terminales, racemiformes vel angustæ; rami floriferi sæpe elongati. Petala alba, glabra. Vexillum sæpius auriculatum. Stamina monadelpha. Discus calyci adnatus, sæpe paullo fimbriatus.

Malay Peninsula to Sumatra, Java, and S. China. Spp. 4, n. 61–64.

Rather closely allied to the African section *Efulgentes*.

9. EFULGENTES, *Dunn in Journ. Bot.* xlix. (1911) 220. Arbores parvæ vel rarius fructices scandentes. Foliola sæpius stipellata, subtus fulgentia. Paniculæ sæpe terminales. Flores subsessiles, in ramulis floriferis congesti;

bracteolæ sæpius magnæ. Calyx sæpe longe lobatus, dense sericeus. Petala glabra, sæpe alba ; vexillum fortiter auriculatum, auriculis inflexis hamos alarum tenentibus ; alæ sæpius transverse rugosæ. Stamina monodelpha. Discus sæpissime fimbriatus, calyci inferius adnatus. Ovarium breve, teres, in stylum longum tenuem angustatum, pauci-ovulatum.

Distributed all through tropical West Africa from the Congo to Sierra Leone. Spp. 25, n. 65–88.

A remarkably compact and natural section, though large.

10. Compresso-gemmatæ, *Dunn in Journ. Bot.* xlix. (1911) 220. Arbores sæpe magnæ. Gemmæ complanatæ. Foliola stipellata, venis multis approximatis parallelis in nervum marginalem euntibus. Paniculæ terminales. Flores magni. Calycis dentes magni, sæpe paullo reflexi. Petala sericea ; vexillum auriculatum. Discus striatus.

From German East Africa and the Congo to S. Africa. Spp. 6, n. 89–94.

Allied to the *Efulgentes* through *M. micans.*

11. Afroscandentes, *Dunn*, sect. nov. Frutices scandentes. Folia sæpissime stipellata, venis impressis. Paniculæ racemiformes, terminales et axillares. Flores fasciculati. Petala sericea ; vexillum exauriculatum.

All West African climbers, except *M. Goetziana*. *M. Barteri* reaches from this region to the northern watershed of the Congo. Spp. 8, n. 95–102.

The section is nearly allied to *Sericanthæ,* being distinguished chiefly by habit.

12. Truncaticalyces, *Dunn*, sect. nov. Arbores parvæ. Foliola exstipellata. Paniculæ racemiformes, axillares. Flores in ramis floriferis congesti. Calyces truncati. Petala glabra. Vexillum exauriculatum. Discus annularis. Ovarium breviter stipitatum vel basi angustatum.

All are small trees from Equatorial Africa, and all on the western watershed of the continent. Spp. 5, n. 103–107.

Connected with the *Efulgentes* by its glabrous petals.

13. Sericanthæ, *Dunn*, sect. nov. Arbores vel frutices erecti. Foliola stipellata vel exstipellata. Racemi axillares. Flores in nodis fasciculati. Petala sericea ; vexillum exauriculatum. Discus sæpius annularis.

East and West Tropical Africa. Spp. 23, n. 108–130.

Connected, as indicated above, with *Afroscandentes* and through ***M. usaramensis*** with the *Polyphyllæ*. ***M. sanagana*** has a close superficial resemblance to *Lonchocarpus sericeus.*

14. Polyphyllæ, *Dunn*, sect. nov. Arbores. Folia multijuga ; foliola parva, oblonga, sæpius stipellata. Racemi axillares. Flores in nodis sessilibus fasciculati. Vexillum exauriculatum. Discus nullus.

A Madagascan section, except for the Congolan *M. gracilis.* Spp. 3, n. 131–133.

It resembles superficially certain stipellate species of *Derris.*

15. ROBUSTIFLORÆ, *Dunn*, sect. nov. Arbores. Folia stipellata. Paniculæ terminales. Flores in nodis sessilibus fasciculati. Calyx alte lobatus. Petala sericea ; vexillum exauriculatum. Stamina protrusa.

Congo Region and Angola. Sp. 1, n. 134.

A distinct type of *Millettia* connected by its calyx and disc characters with *Efulgentes.*

CLAVIS SECTIONUM.

1.	Africana ; foliola parva, oblonga, 9–17-paria	14. *Polyphyllæ* *.
	foliola haud 9–17-paria, oblonga et parva	2
2.	foliola stipellata †	3
	foliola exstipellata	12
3.	vexillum callosum vel auriculatum	4
	vexillum ecallosum et exauriculatum	7
4.	gemmæ globulares	5
	gemmæ compressæ ; foliolorum venæ plurimæ, parallelæ, in venam marginalem currentes	10. *Compresso-gemmatæ.*
5.	flores subsessiles ; petala glabra	9. *Efulgentes.*
	flores longe pedicellati vel petala pubescentia	6
6.	asiatica ; paniculæ vel racemi axillares ; flores fasciculati	7. *Otosema* ‡.
	australasiana ; paniculæ terminales ; flores singuli	2 A. *Austro-millettia.*
7.	asiatica ; pedicelli singuli	8
	pedicelli in nodis vel ramulis fasciculati	9
8.	bracteæ breves	2. *Eurybotryæ.*
	bracteæ floribus longiores	3. *Bracteatæ.*
9.	scandens africana ; foliolorum venæ impressæ	11. *Afroscandentes.*
	erecta vel foliola supra plana	10
10.	paniculæ magnæ, robustæ ; stamina exserta	15. *Robustifloræ.*
	stamina inclusa	11
11.	asiatica	1. *Typicæ.*
	africana §	13. *Sericanthæ.*
12.	vexillum callosum vel auriculatum ; asiatica	13
	vexillum ecallosum et exauriculatum	14
13.	pedicelli capillares ; foliola 5 vel plura	6. *Fragilifloræ.*
	pedicelli breves, crassi ; foliola 1–3	8. *Albifloræ.*
14.	ovarium stipitatum	4. *Podocarpæ.*
	ovarium sessile vel subsessile	15
15.	africana ; calyx truncatus ; corolla glabra	12. *Truncaticalyces.*
	calyx dentatus vel corolla sericea	16 ‖

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* *M. usaramensis* closely resembles this section.

† Stipels minute in *Austro-millettia.*

‡ Or, if the auricles are very slight and the panicle spreading, see no. 2, *Eurybotryæ*

§ But, if a W. African climber, see Sect. no. 11.

‖ Or, if a Philippine tree with slightly callous standards, see no. 6, *Fragilifloræ.*

16.	asiatica; petala glabra vel semina oviformia	17
	africana; petala sericea et semina lenticularia	18
17.	scandens	5. *Macrospermæ.*
	arbor; petala alba, glabra	8. *Albifloræ.*
18.	arbor vel frutex erectus	13. *Sericanthæ.*
	frutex scandens	11. *Afroscandentes.*

CLAVIS SPECIERUM.

§ 1. Typicæ.

1.	Folia subtus fulgentia	2
	folia subtus non fulgentia	3
2.	venæ foliorum 16-pares	1. *splendens.*
	venæ 8-pares	2. *rubiginosa.*
3.	foliola 9–13 cm. longa, supra glabra	4
	foliola 3–5 cm. longa vel, si longiora, supra pubescentia	5
4.	flores 1·1 cm. longi	3. *Griffithii.*
	flores 1·9 cm. longi	4. *macrostachya.*
5.	ramuli floriferi elongati	7. *Brandisiana.*
	nodi floriferi sessiles	6
6.	foliola matura supra velutina	7
	foliola supra fere glabra	8
7.	calycis dentes triangulares; flores 8–9 mm. longi	8. *oraria.*
	calycis dentes acuminati; flores 1·4–1·6 cm. longi	9. *velutina.*
8.	foliola anguste lanceolata; venæ 10–11-jugæ; calyx hirtus	10. *eriocalyx.*
	foliola lanceolata; venæ 8–9-jugæ; calyx pubescens	11. *pulchra.*

§ 2. Eurybotryæ.

1.	Vexillum glabrum	2
	vexillum et calyx sericei	7
2.	calyx glaber vel subglaber	3
	calyx dense sericeus	6
3.	corolla alba vel viridula; carinæ petala cuneata	4
	corolla rosea vel purpurea; carinæ petala hamata vel truncata.	5
4.	foliola 6–7-paria	13. *japonica.*
	foliola 3-paria	12. *Championi.*
5.	stipulæ subulatæ; paniculæ rami ad basin floriferi	14. *reticulata.*
	stipulæ oblongæ; rami basi nudi	15. *eurybotrya.*
6.	folia 6-jugata; flores 3 cm. longi	16. *speciosa.*
	folia 3-jugata; flores ad 2 cm. longi	17. *Fordii.*
7.	semina oviformia	8
	semina lenticularia	10
8.	foliola ad maturitatem subtus tomentosa	18. *oosperma.*
	foliola subtus, saltem matura, glabra	9
9.	panicula robusta	19. *Dorwardi.*
	panicula tenuis	20. *cinerea.*
10.	ovarium breviter stipitatum	21. *sericosema.*
	ovarium sessile	11
11.	panicula floresque graciles	22. *Dielsiana.*
	panicula floresque robusti	23. *nitida.*

§ 2 A. Austro-millettia.

1.	Flores secus apices ramulorum florigerorum aggregati	23 *c. pilipes.*
	flores dissiti	2
2.	Foliola reticulata ; pedicelli calyce paullo longiores	23 *b. australis.*
	foliola lævia ; pedicelli calyce 3–4-plo longiores	23 *a. megasperma.*

§ 3. Bracteatæ.

Species unica	24. *racemosa.*

§ 4. Podocarpæ.

1.	Foliola unijuga vel bijuga	2
	foliola 3–6-juga	4
2.	foliola unijuga	25. *trifoliata.*
	foliola bijuga	3
3.	legumen 16 cm. longum, stipite robusto	26. *podocarpa.*
	legumen ad 10 cm. longum, stipite gracili	27. *Piscidia.*
4.	foliola glabra ; ovula 2	28. *ichthyochtona.*
	foliola subtus tomentosa ; ovula multa	29. *Bonatiana.*

§ 5. Macrospermæ.

1.	Foliola 6–8-paria ; petala glabra	30. *pachycarpa.*
	foliola 2–4-paria ; petala sericea	2
2.	flores paniculati ; foliola subtus fulgentia	31. *sericea.*
	flores racemosi ; foliola subtus opace sericea vel glabra	3
3.	foliola subtus molliter sericea	32. *puerarioides.*
	foliola subtus glabra	33. *caudata.*

§ 6. Fragilifloræ.

1.	Vexillum exauriculatum	18
	vexillum auriculatum	2
2.	vexillum maturum dorso ubique sericeum *	3
	vexillum maturum plerumque glabrum	4

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* Or if a Philippine tree see *M. platyphylla* below :—

34 *a.* M. PLATYPHYLLA, *Merrill, MS.*

Arbor magna, præter inflorescentiam glabra, ad 18 m. alta, cortice griseo rugoso. *Folia* 3-juga, ad 30 cm. longa, petiolo 5-plo longiora ; stipulæ caducæ ; foliola superiora lateralia ovata, caudato-acuminata, basi obtusa, 9–11 cm. longa, membranacea, venis marginem approximantibus 7–8-paribus conspicuis ; petioluli 5 mm. longi ; stipellæ nullæ. *Racemi* axillares, ad 10 cm. longi, rachi ut pedicellis calycibus dorsoque vexilli brunneo-pubescente ; nodi floriferi sessiles, 1–3-flori. *Flores* 1·8–2·0 cm. longi, paullo fragrantes (*Weber*) ; pedicelli graciles, ad 1·5 cm. longi ; bracteæ nullæ ; bracteolæ minimæ, lineares, sæpe a calyce distantes, deciduæ. *Calyx* 4 mm. longus, 8 mm. latus, truncatus, pubescens. *Petala* rubida, inferius flava ; vexilli lamina rotundata, in basin latam fortiter auriculatam abrupte con-

3.	pedicelli 4-5 mm. longi; petala rubida	34. *decipiens.*
	pedicelli 1-1·5 cm. longi; petala cærulea	35. *dehiscens.*
4.	rachis floresque immaturi pubescentes	5
	rachis floresque immaturi glabri vel subglabri; philippinensis	12
5.	folia sub anthesi glabra	6
	folia sub anthesi pubescentia; ovarium dense sericeum	9
6.	leguminis valvæ lenticellatæ, exalatæ	36. *ovalifolia.*
	leguminis valvæ alatæ	7
7.	foliola matura supra nitentia	38. *Prainii.*
	foliola matura utrinque opaca	8
8.	legumen immaturum reticulatum	39. *pterocarpa.*
	legumen immaturum læve	37. *glaucescens.*
9.	foliola fere ad maturitatem ubique tomentosa; legumen alatum.	40. *tetraptera.*
	foliola præcipue vel solum in venis sericea; legumen exalatum.	10
10.	folia fere matura conspicue stipulata	41. *Hemsleyana.*
	stipulæ caducæ	11
11.	racemi robusti versus apices ramorum aphyllorum fasciculati.	42. *Wrightiana.*
	racemi axillares	43. *pubinervis.*
12.	flores paniculati	44. *longipes.*
	flores racemosi	13
13.	leguminis pedicellus 1·5-2 cm. longus	45. *canariifolia.*
	pedicelli florum et leguminum ad 1 cm. longi	14
14.	folia ad 10 cm. longa	46. *Foxworthyi.*
	folia 15-30 cm. longa	15
15.	folia 4-juga	16
	folia 2-juga	17
16.	foliolorum venæ 4-5-pares, inconspicuæ; legumen 7-10 cm. longum	48. *Merrillii.*
	foliolorum venæ 6-7-pares, subtus prominentes; legumen 15-18 cm. longum	50. *Ahernii.*
17.	calyx 4 mm. longus	47. *cavitensis.*
	calyx 2 mm. longus	49. *capillipes.*
18.	folia stipulata	51. *stipulata.*
	folia exstipulata	52. *litoralis.*

§ 7. **Otosema.**

1.	Legumen foliaque griseo-tomentosa	56 *b. cana.*
	legumen foliaque haud griseo-tomentosa	2
2.	vexillum dense sericeum	3
	vexillum glabrum vel subglabrum	6

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tracta, ungue 4-plo longior, dorso ubique adpresse sericea; alæ hamatæ; carinæ petala basi obtusa; stamina monadelpha, vexillare basi solutum. *Discus* nullus. *Ovarium* pubescens, 5-6-ovulatum.

Flowers in March.

Philippine Islands: Mindanao, Subprovince Butuan, West slope of Mt. Hilong-hilong at 300 ft. on rocky soil, *C. M. Weber*, 1123; Province of Misamis (*fide* Merrill), Portolin, *Quadras*, 122.

3.	flores ad 1 cm. longi	4
	flores 1·5 cm. longi	9
4.	foliola obovata	53. *auriculata.*
	foliola oblanceolato-oblonga	5
5.	foliola obtusa	54. *fruticosa.*
	foliola caudato-acuminata	55. *cærulea.*
6.	folia 5–8-juga	7
	folia 2–3-juga	8
7.	stipulæ aciculares, diutius quam folia persistentes	59. *setigera.*
	stipulæ fragiles, mox deciduæ	60. *Cubitti.*
8.	foliola acute acuminata	57. *pendula.*
	foliola obtuse acuminata	58. *latifolia.*
9.	foliola 2·5–3 cm. longa	56 *a. multiflora.*
	foliola 6–10 cm.; venis 13-paribus (si pauciora v. 7)	56. *pachyloba.*

§ 8. Albifloræ.

1.	Flores in racemis axillares	61. *nivea.*
	flores paniculati	2
2.	foliola 3 vel plura	3
	foliolum unicum	64. *unifoliata.*
3.	calycis dentes breves, obtusi	62. *leptobotrya.*
	calycis dentes longi, acuti	63. *albiflora.*

§ 9. Efulgentes.

1.	Foliola subtus fulgentia, sæpe minute stipellata; calycis dentes tubo bis breviores ad bis longiores	2
	foliola sæpius subtus tenuiter sericea, vel glabra, conspicue stipellata, vel, si aliter, calycis dentibus brevibus	12
2.	foliola coriacea; ramuli dense velutini	65. *coruscans.*
	foliola papyracea; ramuli glabrescentes	3
3.	flores in nodis brevibus fasciculati *	4
	flores in ramulis floriferis congesti	6
4.	bracteolæ oblatæ	66. *Harmsiana.*
	bracteolæ angustæ	5
5.	bracteolæ lanceolatæ, calycis tubo longiores	67. *Duchesnei.*
	bracteolæ lineares, minutæ	68. *Solheidii.*
6.	foliolorum venæ 4–5-pares	69. *fulgens.*
	foliolorum venæ 8-pares vel plures	7
7.	bracteolæ calycis tubi dimidio longiores	8
	bracteolæ calycis tubo 4-plo vel plus breviores	9
8.	flores sessiles	70. *lucens.*
	pedicelli 3 mm. longi †	71. *urophylloides.*
9.	stipellæ conspicuæ	72. *hypolampra.*
	stipellæ obsoletæ	10
10.	panicula aphylla	11
	panicula foliosa	75. *Klainei.*

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* *M. dubia* should also be seen. † *M. atenensis* should also be compared.

11.	foliolum terminale cuneatum, abrupte acuminatum	73. *Lecomtei.*
	foliolum terminale oblongo-lanceolatum	74. *Dinklagei.*
12.	ramuli floriferi 4–5 cm. longi	13
	ramuli floriferi ad 2 cm. longi	19
13.	flores 2·0 cm. longi; foliola subtus reticulata	76. *aureocalyx.*
	flores 1·2–1·5 cm. longi; venæ laterales tantum prominentes.	14
14.	foliola 9–20 cm. longa vel si breviora subglabra	15
	foliola 2–5 cm. longa, subtus pubescentia	18
15.	foliola caudata; dentes calycis tubo æquilongi	77. *bipindensis.*
	calycis dentes tubo breviores	16
16.	foliola glabra vel sparsissime pubescentia	17
	foliola lucentia hirtis adpressis	80. *chrysophylla.*
17.	foliola 10–20 cm. longa	78. *melanocalyx.*
	foliola ad 7 cm. longa	22
18.	foliola anguste oblonga, subtus sparse hirta	81. *Scott-Ellioti.*
	foliola oblongo-ovata, subtus molliter sericea	82. *Warneckii.*
19.	foliola 5–6-paria	83. *Sapini.*
	foliola 2–4-paria	20
20.	corolla nigrescens	85. *Cabræ.*
	corolla siccitate haud nigrescens	21
21.	foliola 2-paria	86. *Tholloni.*
	foliola 4-paria	23
22.	calyx dense sericeus	79. *porphyrocalyx.*
	calyx tenuiter sericeus	79 *a. rhodantha.*
23.	foliola ovata, omnino glabra	87. *macroura.*
	foliola oblongo-lanceolata, subtus tenuiter adpresse sericea.	24
24.	foliolorum venis 10-paribus	88. *dubia.*
	foliolorum venis 6-paribus	84. *congolensis.*

§ 10. **Compresso-gemmatæ.**

1.	Corolla glabra	2
	corolla sericea	3
2.	stipulæ magnæ; foliola 4-paria, obtusa	89. *Stuhlmannii.*
	stipulæ minutæ; foliola 6-paria, acuminata	90. *Laurentii.*
3.	vexillum hirsutum, ad 2·5 cm. longum	4
	vexillum tenuiter sericeum, 3·5 cm. longum	94. *Sacleuxii.*
4.	foliola supra velutina, subtus mollia	91. *micans.*
	foliola subglabra	5
5.	foliola ovata	92. *versicolor.*
	foliola oblonga	93. *caffra.*

§ 11. **Afroscandentes.**

1.	Foliolorum venæ supra impressæ	2
	foliolorum venæ haud impressæ	102. *Barteri.*
2.	foliola hirsuta, exstipellata vel minute stipellata; bracteæ longæ, lineares	3
	foliola subglabra; bracteæ breves	6
3.	foliola subtus molliter sericeo-tomentosa	4
	foliola haud tomentosa	5

4. stipulæ persistentes; stipellæ nullæ .... 95. *Soyauxii.*
stipulæ caducæ; stipellæ conspicuæ .... 96. *hirsuta.*
5. foliola subtus adpresse sericea .... 97. *Gagnepainiana.*
foliola subtus tenuiter hirta .... 98. *bicolor.*
6. foliola stipellata 7
stipellæ nullæ .... 101. *calabarica.*
7. foliola obtusa; flores 1·5 cm. longi .... 99. *Goetziana.*
foliola acuminata; flores 1 cm. longi .... 100. *impressa.*

§ 12. **Truncaticalyces.**

1. Foliola subtus glabra 2
foliola subtus tomentosa .... 107. *aboensis.*
2. foliola 6–11-paria 3
foliola 2–4-paria 4
3. vexillum 1·8–2·4 cm. diam. .... 103. *macrophylla.*
vexillum 1–1·2 cm. diam. .... 104. *Mannii.*
4. foliola caudata .... 105. *psilopetala.*
foliola obtuse acuminata .... 106. *Thonneri.*

§ 13. **Sericanthæ.**

1. Bracteæ bracteolæque floribus breviores 2
bracteæ bracteolæque floribus longiores 22
2. foliola exstipellata * 3
foliola stipellata 8
3. pedicelli calyce multo longiores 4
pedicelli calyce breviores 5
4. foliola 2-paria, subtus pubescentia .... 108. *paucijuga.*
foliola 3–5-paria, glabra .... 109. *Thonningii.*
5. calyx truncatus .... 110. *sanagana.*
calyx dentatus 6
6. foliola 8-paria .... 111. *Zechiana.*
foliola 4–5-paria 7
7. foliola glabra .... 112. *Stapfiana.*
foliola subtus tomentosa .... 113. *nudiflora.*
8. foliola 6–10-paria 9
foliola 2–4-paria 21
9. pedicelli calyce breviores vel vix longiores 10
pedicelli calyce multo longiores 17
10. foliola immatura subtus præter venas subglabra; flores ad 2·0 cm. longi 11
foliola immatura subtus pubescentia vel velutina; flores longiores quam 2·2 cm. 15
11. foliola 6-paria, omnino glabra 12
foliola 7–10-paria, venis saltem pubescentibus 13
12. foliola siccitate viridula .... 114. *pallens.*
foliola nigrescentia .... 115. *Conraui.*
13. foliola supra glabra 14
foliola utrinque paullo pubescentia .... 118. *brevistipellata.*

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* *M. Zechiana* has occasionally minute stipellæ.

14. foliola 10–12 cm. longa .... 116. *Sereti.*
foliola 5–7 cm. longa .... 117. *drastica.*
15. foliola venis supra impressis .... 119. *cyanantha.*
foliola supra plana 16
16. foliola subtus præter costam dense ferrugineam subglabra .... 120 *a. aromatica.*
foliolorum vestitus homogeneus .... 120. *ferruginea.*
17. foliolorum venæ supra impressæ .... 124. *eriocarpa.*
foliola plana 18
18. calyx ferrugineus vel legumen 15 cm. longum 19
calyx subglaber; legumen brevius quam 6 cm. .... 123. *usaramensis.*
19. foliola superiora breviora quam 4 cm.; legumen 15 cm. longum. 125. *leptocarpa.*
foliola superiora longiora quam 6 cm. 20
20. flores 2·5–2·7 cm. longi; vexillum rotundatum .... 121. *dura.*
flores 1·7–2·2 cm. longi; vexillum oblatum .... 122. *oblata.*
21. rachis paniculæ calyxque breviter sericei .... 127. *lasiantha.*
rachis paniculæ calyxque dense velutini .... 128. *leucantha.*
22. foliola oblanceolata .... 129. *Bussei.*
foliola ovata .... 130. *sericantha.*

§ 14. **Polyphyllæ.**

1. Stipellæ setaceæ, conspicuæ .... 131. *gracilis.*
stipellæ obscuræ vel nullæ 2
2. stipellæ minutæ, nunquam absentes .... 132. *polyphylla.*
stipellæ nullæ .... 133. *lenneoides.*

§ 15. **Robustifloræ.**

Species unica .... 134. *Theuszii.*

1. M. SPLENDENS, *Wight et Arn. Prodr.* 263; *Baker in Hook. f. Fl. Brit. Ind.* ii. 104; *Bedd. Ic. Pl. Ind. Or.* t. 295.

Frutex scandens (?) ramulis velutinis tandem glabrescentibus scaberulis striatis. *Folia* 3–4-juga, 25–35 cm. longa, petiolis 4-plo longiora, rachi ut petiolulis et panicularum rachibus ramulisque et pedicellis breviter velutina; stipulæ triangulares, 3–4 mm. longæ; foliola superiora lateralia obovato-oblonga vel oblanceolato-oblonga, breviter acuminata, basi cuneata vel obtusa, 11–16 cm. longa, coriacea, supra glabra, infra adpresse sericea, argentea, splendida, venis marginem approximantibus 14–16-paribus rectis parallelis infra prominentibus; stipellæ setaceæ, persistentes, 2–3 mm. longæ. *Paniculæ* racemiformes axillares vel paniculam generalem foliatam terminalem formantes, 25–40 cm. longæ; ramuli floriferi multiflori ad 1 cm. longi, in basi nudi. *Flores* dense fasciculati, 1·3 mm. longi; pedicelli 2 mm. longi; bracteæ nullæ; bracteolæ ovatæ, 1–2 mm. longæ. *Calyx* late campanulatus, 5 mm. longus, 5 mm. latus, dense pubescens, dentibus duobus superioribus fere ad apicem coalitis, ceteris anguste triangularibus tubo bis brevioribus. *Vexillum* late ovatum, basi truncatum, in unguem abrupte angustatum, exauriculatum, paullo crispatum, extus dense sericeum; alæ oblongæ, subfalcatæ; carinæ petala in unguem abrupte angustata. *Stamina* tandem diadelpha. *Discus* 0. *Ovarium* lineare, dense velutinum, 4-ovulatum. *Legumen* lineare, 9 cm. longum, 1·7 cm. latum, velutinum, tarde dehiscens, valvis tenuiter lignosis inter semina cohærentibus. *Semina* oblongo-ovalia, fusca, nitentia.

Flowers in June, fruits July to November.

S. INDIA: Nilgiri Hills, *Wight*, 998 (*type*), Kew Dist. 807, *Thomson*, *Gamble*, 16195 (Coonoor Ghat at 4000 feet), 14353, 22580, 17778; Goodaloor Ghat, *Lawson*; Anamali Hills, *Beddome* (3000 feet).

2. M. RUBIGINOSA, *Wight et Arn. Prodr.* 263; *Wight Ic.* t. 207; *Baker in Hook. f. Fl. Brit. Ind.* ii. 104; *Miq. Fl. Ned. Ind.* i. 154.

Frutex scandens ramis primo ferrugineis tandem glabris lævibus. *Folia* 3-juga, 25–30 cm. longa, petiolis 5-plo longiora, rachi ut petiolulis rachique paniculæ breviter dense tomentosa; stipulæ nullæ; foliola superiora lateralia ovato-lanceolata, acuminata, basi obtusa, 12–18 cm. longa, subcoriacea, supra glabra, nitida, subtus adpresse sericea, fulgentia, tandem nonnunquam fere glabra, venis marginem appropinquantibus 9–10-paribus, infra prominentibus; petioluli 11–13 mm. longi; stipellæ setaceæ, 1–2 mm. longæ, pubescentes. *Paniculæ* racemiformes axillares et in generalem paniculam foliosam terminalem nonnunquam aggregatæ, 20–30 cm. longæ; nodi floriferi globulares, in stipitibus crassis 4–5 mm. longis, multiflori. *Flores* fasciculati, 12–13 mm. longi; pedicelli 1–2 mm. longi; bracteæ nullæ; bracteolæ 1–1·5 mm. longæ, ovatæ. *Calyx* campanulatus, 3–4 mm. longus et latus, dense pubescens, dentibus inconspicuis. *Vexilli* 2·5–2·6 cm. longi, lamina ovata, basi subtruncata, ungui 6-plo longior, dorso omnino facie in ungui solum sericea; alæ oblongæ, in unguem gradatim augustatæ; carinæ petala conformia sed dorso tenuiter hirsuta. *Stamina* diadelpha. *Discus* 0. *Ovarium* lineare, dense pubescens, 4-ovulatum. *Legumen* oblongum, apice basique obtusum, 8 cm. longum, 3·5 cm. latum, velutinum, tarde dehiscens, valvis coriaceis inter semina cohærentibus. *Semina* lenticularia.

Flowers in June, fruits in November and December.

S. INDIA: Courtallum, *Wight*, 813 (Kew Dist.), 912 (*type*), 245, 246; Travancore, *Meebold*, 13078 (4000–5000 feet); Tinnevelli, *Barber*, 3107.

The dehiscence is clearly shown in quite mature fruiting specimens.

60132 3. M. GRIFFITHII, *Dunn*, sp. n.

Frutex demum scandens, cortice primo sericeo cito glabro. *Folia* 4-juga, 40 cm. longa, petiolo 4-plo longiora, rachi ut foliolis præcipue subtus tenuiter pubescente; stipulæ parvæ, persistentes, ovatæ, 1–2 mm. longæ; foliola superiora lateralia oblongo-lanceolata, acuminata, basi acuta, 10–12 cm. longa, papyracea, venis marginem appropinquantibus 8–9-paribus parum conspicuis; petioluli 2–3 mm. longi; stipellæ setaceæ, 1–1·5 mm. longæ. *Racemi* axillares, 20–30 cm. longi, rachi ut pedicellis calycibusque adpresse sericea; nodi floriferi globulares, sessiles, pauciflori; bracteæ bracteolæque minutæ, lineares. *Flores* laxi, 1 cm. longi; pedicelli 3 mm. longi. *Calyx* 3 mm. longus, campanulatus, dentibus tubo 3-plo brevioribus. *Petala* præter vexillum extus carneum purpurea; vexilli lamina rotundata, in unguem brevem angustata, extus pubescens; alæ carinæque petala oblongæ, hamatæ. *Stamina* monadelpha, vexillare basi solutum. *Discus* nullus. *Ovarium* lineare, breviter stipitatum, sericeum, 3-ovulatum.

Flowers in May.

UPPER BURMA: *Griffith*, 1783 (towards Silver Mine woods, at 1000–1200 feet).

4. M. MACROSTACHYA, *Coll. et Hemsl. in Journ. Linn. Soc., Bot.* xxviii. (1890) 41; *Prain in Journ. As. Soc. Beng.* lxvi. II. (1897) 361.

Frutex vel *arbor* parva, cortice lævi lenticellato. *Folia* (3–)4–5-juga, 30–40 cm. longa, petiolis 4–5-plo longiora, rachi foliorum paniculæque molliter tenuiter pubescente vel fere glabra; stipulæ nullæ; foliola superiora lateralia oblonga vel oblongo-ovata, breviter acuminata, infra molliter pubescentia mox glabrescentia, venis marginem approximantibus 8–10-paribus arcuatis, infra prominentibus; stipellæ setaceæ, 1–2 mm. longæ. *Paniculæ* racemiformes, axillares, 40–50 cm. longæ; nodi floriferi globosi, in stipite 2–4 mm. longo, pauciflori. *Flores* fasciculati, 1·8 cm. longi; pedicelli 4–5 mm. longi, pubescentes vel fere glabri. *Calyx* campanulatus, 7 mm. longus, tenuiter pubescens, dentibus 4 angustis acuminatis tubo fere æquilongis, superiore apice bifido. *Petala* delicate rubida; vexilli lamina subrotunda, basi subcordata ungui 5-plo longior, dorso apice hirtella; alæ oblongæ, breviter falcatæ; carinæ petala fortiter falcata. *Stamina* monadelpha, vexillare basi solutum. *Discus* nullus. *Ovarium* lineare, pubescens, multiovulatum. *Legumen* lineare, 16 cm. longum, 1·5–2 cm. latum, glabrum, elastice dehiscens, valvis robuste coriaceis inter semina liberis.

Flowers in March, fruits in August.

UPPER BURMA, Maimyo, *Manders* (at 4000 ft., *type*).

SHAN STATES, Shan hills terai, *Collett*, 443, 605 (at 2000 ft., *types*); Taungyi, *Abdul Khalil*; Longcong Hill, *King's Collector, Robertson*, 289 (rocky banks of Salween at Mong-hai).

7. M. BRANDISIANA, *Kurz in Journ. As. Soc. Beng.* xlii. II. (1873) 69; *For. Fl. Brit. Burm.* 355; *Baker in Hook. f. Fl. Brit. Ind.* ii. 108; *Gamble, Manual Ind. Timb.* (1902) 232; *Collett et Hemsl. in Journ. Linn. Soc., Bot.* xxviii. (1890) 40.—Pongamia cassioides, *Wall. Cat.* n. 5918.

Arbor ad 20 m. alta, cortice griseo rugoso lenticellato, novellis cupreo-pubescentibus. *Folia* 7–10-juga, 15–30 cm. longa, petiolo 6-plo longiora, rachi ut paginis inferioribus foliolorum et ut rachi panicularum primo adpresse pubescente, tandem fere glabra ; stipulæ nullæ ; foliola oblongo-lanceolata, acuta vel breviter acuminata, apice summo obtusa, 3–6 cm. longa, chartacea, venis marginem propinquantibus 7–9-paribus sæpius inconspicuis in fructu autem nonnunquam infra paullo prominentibus ; petioluli 4 mm. longi ; stipellæ setaceæ, 1–1·5 mm. longæ. *Paniculæ* racemiformes, in ramulis summis infra folia collecti et sæpe ante ea evolutæ, 10–20 cm. longæ ; ramuli florifera 0·2–1·0 cm. longi, secus basin nudi, 2–6-flori. *Flores* fasciculati, 1·2 cm. longi ; pedicelli 3-4 mm. longi ; bracteæ nullæ ; bracteolæ lineares, minutæ, sæpe paullo infra calycem insertæ. *Calyx* campanulatus, 5–6 mm. longus, tenuiter pubescens sæpe fere glaber ; dentibus 4, tribus inferioribus triangularibus tubo 2–3-plo brevioribus, superiore obtuso emarginato. *Petala* pallide cærulea ; vexilli lamina ovata basi truncata, ungui 2–3-plo longior, exauriculata, extus dense sericea ; alæ oblongæ basi truncatæ ; carinæ petala oblonga in unguem angustata. *Stamina* monadelpha, vexillare basi solutum. *Discus* nullus. *Ovarium* pubescens, multiovulatum. *Legumen* lineare, ad 13 cm. longum, 2·5 cm. latum, glabrum, suturis paullo incrassatis, elastice dehiscens, inter semina primo cohærens, 1–4-spermum.

Flowers in March, fruits from October to March.

UPPER BURMA : Poneshee, *Anderson* ; Upper Chindwin, *Lace*, 4181 (at 400 ft.) ; Katha District, *Lace*, 4435 ; Yamethin, *Lace*, 4529 ; Chin Hills, *Dun*, 99 ; Minguin, *Prazer* ; Minbu, *Aubert et Gage*, *Lace*, 2710, 4674.

LOWER BURMA : Yoma, *Kurz*, 1773 (*type*) ; Pegu, *Kurz*, 2538 (*type*), *Brandis* (*type*), *Eyre* (*type*), *Hodgson* ; Henzada, *Shaik Mokim*, 1322 ; Tenasserim, *Gallatly*, 107, 147, 160, *Aplin*, *Wall. Cat.* 5918 (Taoung Dong).

SHAN STATES : Karen Hills, *Brandis* ; *Abdul Huk*, 147 ; *Collett*, 15.

SIAM : *Hort. Bogor.* 3438 ; *Hosseus*, 140 ; *Kerr*, 985, 2029.

Burmese name *Thitpagan*, Lao name *Pi Chan*. In the regions above indicated it occurs in the dry hill forests as a spreading tree of medium size. Hodgson, in a note attached to specimens in the Herbarium of the Reporter on Economic Products to the Government of India kindly lent to me by Mr. I. H. Burkill, says that it is "called in Burmese *Pokthinmamyetkouk* (the eyelid of the Chameleon). This tree when it first puts forth its new leaves in March–April is pale salmon, changing quickly through pink, magenta, and purple to green. The flowers are violet in colour and are not sweet-scented. The tree attains (though rarely) a girth of over 6 feet and is 40–60 feet in height."

The typical form is distinguished from its allies by its stalked flower-nodes, the densely silky, almost shaggy standard of its flowers, and by its nearly glabrous calyx which darkens on drying. The specimens noted above show a little variation both in the pubescence of the calyx and in the form and clothing of the leaflets. The latter, especially in the higher portions of the

specific area, become a little shorter and blunter than in the typical Pegu forms and have rather more prominent nerves. In Collett's n. 15 the calyx is more than usually pubescent, while in Lace's n. 4435 the persistent tomentum on the veins of its leaflets may indicate the presence of a distinct species, though, in the absence of flowering shoots, it cannot at present be usefully separated. Gamble (*l. c.*) describes the bark and wood, which are represented in Kew Museum, No. I., by specimens contributed by him.

8. M. ORARIA, *Dunn*, nom. nov.—Tephrosia oraria, *Hance in Journ. Bot.* xxiv. (1886) 17.

Frutex erectus, cortice lævi, ramis breviter velutinis ut rachibus foliolorum racemorumque et petiolulis. *Folia* 6–7-juga, 15–20 cm. longa, petiolis 4-plo longiora; stipulæ persistentes, lanceolatæ, 2–3 mm. longæ; foliola superiora lateralia elliptica, apice sæpius rotundata, basi obtusa, 3–5 cm. longa, papyracea, supra ad maturitatem velutina subtus tomentosa, venis marginem approximantibus 5–6-paribus inconspicuis; petioluli 2 mm. longi; stipellæ 2 mm. longæ, setaceæ. *Racemi* axillares, ad apicem ramorum conferti, 7–8 cm. longi, basi breviter nudi. *Flores* 8–9 mm. longi; bracteæ bracteolæque minutæ, lanceolatæ. *Calyx* campanulatus, 3 mm. longus, sericeus, dentibus tubo 6-plo brevioribus. *Vexilli* lamina rotundata, in unguem 5-plo breviorem abrupte angustata, dorso sericea; alæ oblongæ, subhamatæ; carinæ petala ovata, basi truncata. *Stamina* diadelpha. *Ovarium* lineare, sericeum, 4-ovutatum. *Legumen* ad 8 cm. longum, 1·2 cm. latum, velutinum, lineare, facile dehiscens, 2–4-spermum.

CHINA: Hongkong, Cape d'Aguilar, *Ford*; Kwangtung, *Ford*, 35.

9. M. VELUTINA, *Dunn*, sp. n.—M. yunnanensis, *Pamp.*, *var.* robusta, *Pamp. in Nuov. Giorn. Bot. Ital.* N. S. xvii. (1910) 27.

Arbor parva, ramis primo dense velutinis tandem glabris. *Folia* 7–8-juga, 25–35 cm. longa, petiolo 7–8-plo longiora, rachi ut petiolulis et rachibus racemorum tomentosa; stipulæ oblongæ, deciduæ, 2–3 mm. longæ; foliola superiora lateralia oblonga, apice acuta vel obtusa, basi obtusa, 7–10 cm. longa, papyracea, supra velutina, subtus breviter tomentosa, venis marginem approximantibus 7-paribus inconspicuis; petioluli 2–2·5 mm. longi; stipellæ persistentes, setaceæ, 2 mm. longæ. *Racemi* in ramis summis collecti, axillares, ad 20 cm. longi, basi breviter nudi; nodi floriferi globulares, 4–5-flori. *Flores* fasciculati, 1·3–1·6 cm. longi; pedicelli 2–3 mm. longi; bracteæ bracteolæque minutæ, lanceolatæ, persistentes. *Calyx* campanulatus, 5 mm. longus, tenuiter sericeus, dentibus tubo æquilongis, 2 superioribus coalitis, ceteris acuminatis. *Petala* rubida; vexilli lamina ovata, basi truncata, in apice dorso paullo sericea, ungui 3-plo longior; alæ carinæque petala basi subtruncatæ. *Stamina* monadelpha, vexillare basi solutum. *Ovarium* sericeum, lineare, 6-ovulatum. *Legumen* lineare, ad 12 cm. longum, 1·3 cm.

latum, 3–5-spermum, breviter dense tomentosum, facile dehiscens, valvis tenuiter lignosis inter semina liberis. *Semina* castanea, oblonga, compressiuscula, 1·2 cm. longa, 8 mm. lata.

Flowers in May.

CHINA: Yunnan, Yunnan-sen, *Maire*, 160. Mengtze, *Henry*, 9728 (4600–5000 ft.), 9728 B (5000 ft.), 9728 D (4600 ft.), 9728 F.

10. M. ERIOCALYX, *Dunn*, sp. n.—M. pulchra, *Prain in Rec. Bot. Surv. Ind.* i. 237, non *Kurz.*

Frutex (?) ramis ut rachibus foliorum racemorumque dense ferrugineis, tarde glabrescentibus. *Folia* 9–10-juga, 25–30 cm. longa, petiolo 5-plo longiora; stipulæ lanceolatæ, 1 mm. longæ, persistentes; foliola superiora lateralia lineari-lanceolata, apice acuta, basi cuneata, 7–8 cm. longa, papyracea, supra breviter pubescentia, subtus tomentosa, venis marginem appropinquantibus 6-paribus ascendentibus inconspicuis; petioluli 2 mm. longi; stipellæ setaceæ, persistentes, 1–2 mm. longæ. *Racemi* inter folia in apice rami fasciculati, axillares vel sæpius infra folia laterales, 10–20 cm. longi, basi breviter nudi; nodi floriferi globosi, 3–5-flori. *Flores* fasciculati, 1·2–1·4 cm. longi; pedicelli 3 mm. longi; bracteæ bracteolæque lanceolatæ, persistentes, 1 mm. longæ. *Calyx* campanulatus, 4 mm. longus, longe et laxe sericeus, dentibus tubo bis brevioribus. *Vexilli* lamina rotundata, in unguem brevem abrupte angustata, dorso tenuiter sericea; alæ carinæque petala oblongæ, subhamatæ, apice paullo pubescentes. *Stamina* monadelpha, vexillare basi solutum, perigyna. *Ovarium* lineare, pubescens, 4-ovulatum.

Flowers March to June.

UPPER BURMA: Myitkyina on the Irrawaddy, *Shaik Mokim.*

11. M. PULCHRA, *Kurz. in Journ. As. Soc. Beng.* xlii. II. (1873) 69, xlv. 274; *Benth. ex Baker in Hook. f. Fl. Brit. Ind.* ii. 104 (1876); *Kurz, For. Fl. Brit. Burma*, 355; *Prain in Journ. As. Soc. Beng.* lxvi. II. (1897) 358; *Gamble, Manual Ind. Timb.* 232 (1902); *Dunn and Tutcher, Fl. Kwangt.* 77.—Tephrosia pulchra, *Colebr. in Wall. Cat.* n. 5630. Dalbergia tephrosioides, *Wight et Arn. Prodr.* 210 (*nomen*). Mundulea pulchra, *Benth, in Miq. Pl. Jungh.* 248. M. yunnanensis, *Pamp. in Nuov. Giorn. Bot. Ital.* N. S. xvii. (1910) 26 (*excl. var.*). Tephrosia Tutcheri, *Dunn. in Journ. Bot.* xlvii. (1909) 197. M. ?, *Forbes et Hemsl. in Journ. Linn. Soc., Bot.* xxiii. (1886) 159.

Frutex erectus vel rarius scandens, vel arbor, cortice griseo rugoso, ramis ut rachibus foliorum et racemorum primo dense tandem tenuiter ferrugineis lenticellatis. *Folia* 7–9-juga, 8–30 cm. longa, petiolo 4-plo longiora; stipulæ persistentes, lanceolatæ, 2 mm. longæ; foliola superiora lateralia lanceolata, acuta, basi acuta vel sæpius obtusa, 2–6 cm. longa, papyracea, supra fere glabra, subtus tenuiter sericea, venis marginem appropinquantibus 4–6-paribus inconspicuis; petioluli 1–2 mm. longi; stipellæ setaceæ, 1–2 mm.

longæ. *Racemi* axillares, sæpe in apice ramorum approximati vel fasciculati, 6–20 cm. longi, pedunculo 3-plo longiores; nodi floriferi 3–4-flori, approximati, globulares, vel rarissime paullo elongati, ferruginei. *Flores* fasciculati, 0·9–1·2 cm. longi; pedicelli 3–4 mm. longi; bracteæ bracteolæque lanceolatæ, persistentes, 0·5–1 mm. longæ. *Calyx* campanulatus, 4 mm. longus, dense sericeus, dentibus tubo 2-plo breviores, duo superiora ad apicem fere coalita, ceteris triangularibus vel rarius acuminatis. *Petala* purpurea, fere glabra; vexilli lamina ovata, basi truncata, paullo sagittata, apice dorso sericea, ungue 2–3-plo longior; alæ paullo falcatæ; carinæ petala in unguem subito angustata. *Stamina* monadelpha, vexillare basi solutum. *Discus* 0. *Ovarium* lineare, sericeo-pubescens, 5-ovulatum. *Legumen* oblongum, 4–8 cm. longum, 1–2 cm. latum, tandem glabrum, facile dehiscens, valvis tenuiter lignosis, inter semina liberis. *Semina* lenticularia.

CLAVIS VARIETATUM ET FORMARUM.

1.	Foliola infra pubescentia	2
	foliola infra tomentosa; calyx hirsutus	var. *tomentosa*.
2.	calycis dentes acuminata	3
	calycis dentes triangulares	4
3.	foliola magna	var. *yunnanensis*.
	foliola parva, elliptica	var. *chinensis*.
4.	foliola parva, margine sericea	var. *microphylla*.
	foliola margine glabra	5
5.	foliola parva; folia ad apicem ramulorum conferta	var. *typica*.
	foliola majora; folia et racemi laxi, distantes	var. *typica* f. *laxior*.

Var. 1. TYPICA. Folia racemique in apice ramulorum conferti. Foliola parva, lanceolata, infra pubescentia. Calycis dentes triangulares. Sæpe semiscandens.

ASSAM: Khasi Hills, *Wall. Cat.* 5630 pp. (Silhet *type*), *Herb. Kurz*, *Gammie*, 492, *Gallatly*, 198, *C. B. Clarke*, 7328, 43713, *Hook. f. et Thoms.*; Kachin Hills, *Pottinger*, *King's Collector*, *Hort. Bot. Calcutta*.

IC. INED. Colebrook, 558 (Libr. Kew.).

Var. 1. TYPICA, forma LAXIOR.—Tephrosia Tutcheri, *Dunn in Journ. Bot.* xlvii. (1909) 197. Simulis sed foliola majora, folia racemique secus ramulos dispersi.

ASSAM: Khasia, *Wall. Cat.* 5630 pp. 5630 c (Silhet, *types*), *Hook. f. et Thoms.* 698, *Clarke*, 15194, 44713, *Griffith*, Kew Dist. 1784, 1791, *Badal Khan*, *Watt*, 11758, *Gammie*, 420, 488; Manipur, *Watt*, 6746, *Anderson*; Kohima, *King's Collector*, 188.

CHINA: *Millett*; Kwangtung, *Ford*, 38, *Parker*, 107 (Canton); Hongkong, *Ford*, 503, 644; Hongkong New Territory, *Ford*, 403 (Lantao) Hainan, *B. C. Henry*, 45.

Var. 2. TOMENTOSA, *Prain in Journ. As. Soc. Beng.* lxvi. II. (1897) 358. Folia oblonga, infra tomentosa; calyx hirsutus.

ASSAM: Manipur, *Watt*, 6254 (*type*), *Meebold*, 5337; Naga Hills, *Prain*.
UPPER BURMA: Ruby-Mines, *Rodger*, 305.

60552 Var. 3. CHINENSIS, *Dunn*, var. nov. Habitus var. *typicæ*; foliola autem parva, elliptica; calycis dentes acuminati; petala rubido-purpurea. Frutex vel arbor 2–10 m. alta.

CHINA: Yunnan, *Henry*, 12322 (Szemao forest, 4000 feet), 13031 (Szemao East Mountains at 4500 feet).

60555 Var. 4. YUNNANENSIS, *Dunn*, var. nov.—M. yunnanensis, *Pamp. in Nuov. Giorn. Bot. Ital.* N. S. xvii. (1910) 26 (exclud. var.). Var. *typicæ* formæ *laxiori* similis sed major, calycisque dentibus acuminatis.

SHAN STATES, *MacGregor*, 618.
CHINA: Yunnan, *Maire*, 142, 165 (*types*), *Ducloux*, 2 (Yunnanfu).

Var. 5. MICROPHYLLA, *Dunn*, var. nov. Frutex foliolis parvis margine albo-sericeis, calycis dentibus acuminatis.

CHINA: Formosa, *Henry*, 994.

The small-leafed semiscandent form, which was among the first discovered, occurs only, so far as is known, in the Khasia Hills, whence it was procured for the Calcutta Botanic Gardens. From the wild and cultivated trees specimens were included in Wallich's Herbarium under n. 5630. The laxer form was collected at the same time in the wild state and was included under the same Wallichian number, while in Wallich's own herbarium it was actually mounted on the same sheet. It is far more widely distributed than the typical form, ranging eastwards as far as the coasts of China. Peculiar varieties occur on the extreme east and south of this area, described above as var. *microphylla* and var. *tomentosa*.

The species, as a whole, is more widely distributed than any other *Millettia*, covering 40 degrees of latitude and 20 of longitude.

The bark and wood are described by Gamble (*l. c.*) and are represented by his specimens in the Kew Museum, No. I.

12. M. CHAMPIONI, *Benth. in Kew Journ. Bot.* iv. (1852) 74; *Benth. in Seem. Voy. 'Herald,'* 375; *Benth. Fl. Hongk.* 79; *Forbes et Hemsl. in Journ. Linn. Soc., Bot.* xxiii. (1886) 159; *Dunn and Tutcher, Fl. Kwangt.* 76.

Frutex scandens, cortice fusco striato, præter inflorescentiam glabra. *Folia* 2-juga, 10–20 cm. longa, petiolo 4-plo longiora; stipulæ anguste lineares, 2–3 mm. longæ; foliola superiora lateralia ovata vel oblonga, gradatim obtuse acuminata, 3–6 cm. longa, papyracea, crebre reticulata, viridia, nitentia, venis marginem propinquantibus 4–5-paribus; petioluli

1–3 mm. longi; stipellæ 2–3 mm. longæ, setaceæ. *Panicula* terminalis, sæpissime extra-axillaris, ad 15 cm. longa, rachi ut ramis superne pubescente; rami floriferi patentes, 6–8 cm. longi, pedunculos 4–5-plo excedentes. *Flores* approximati sed singuli, 12 mm. longi; pedicelli 3–4 longi, ut calyces glabri vel rarius laxe puberuli; bracteæ 1–2 mm. longæ, anguste lanceolatæ, tarde deciduæ. *Calyx* expansus late campanulatus, 2 mm. longus, 4 mm. latus, margine anguste tomentosus, dentibus tubo 4–5-plo brevioribus late ovatis; bracteolæ persistentes, ovatæ, calyce bis breviores. *Petala* viridula, glabra; vexilli lamina ovata, basi ecallosa, in unguem 3-plo breviorem subito angustata; alæ basi cuneatæ; carinæ petala in unguem abrupte angustata, sæpius paullo semicordata. *Stamina* diadelpha, vexillare solutum. *Discus* 1–2 mm. longus, tubulosus. *Ovarium* basi in stipitem gradatim angustatum, multiovulatum, glabrum. *Legumen* lineare, basi cuneatum, 6–12 cm. longum, 1–1·5 cm. latum, valvis tenuiter lignosis elasticis inter semina cohærentibus fuscis. *Semina* 2–3 lenticularia.

Flowers in summer, fruits in autumn and winter.

CHINA: Hongkong, *Champion*, 263 (*type*), *Forbes*, 589, *C. Wright*, 136, *Hongkong Herb.* 1253 (Sukunpo and Mt. Gough); Hongkong New Territory, *Hongkong Herb.* 9393 (Ma-on-shan); Island near Hongkong, *Tate*.

Nearest to *M. reticulata*, but readily distinguished from that species when growing by its slenderer habit and smaller pale green flowers.

13. M. JAPONICA, *A. Gray in Mem. Amer. Acad.* n. s. vi. (1859) 386; *Franch. et Savat. Enum. Pl. Jap.* i. 98.—Wistaria japonica, *Sieb. et Zucc. Fl. Jap.* i. 88; *Miq. Prol. Fl. Jap.* 232.

Frutex in arboribus volubilis, fere omnino glaber, cortice cinereo-fuscescente, ramulis virentibus. *Folia* 4–6-juga, 12–18 cm. longa, petiolo 7–8-plo longiora; stipulæ minutæ, setaceæ, persistentes; foliola superiora lateralia ovato-lanceolata, obtuse acuminata, basi cuneata vel obtusa, 2·5–5 cm. longa, papyracea, infra reticulata, venis marginem propinquantibus 5–6-paribus, infra prominentibus; petioluli 1 mm. longi; stipellæ 1 mm. longæ, setaceæ, persistentes. *Paniculæ* magnæ, terminales, laxæ, nutantes, basi foliatæ, vel sæpe racemi longi, axillares, penduli, ad 20 cm. longi. *Flores* solitarii, 1·4–1·6 cm. longi, albi; pedicelli 4 mm. longi; bracteæ lineares, 2 mm. longæ; bracteolæ lineares, 1·5 mm. longæ, deciduæ. *Calyx* campanulatus, 3·5–4 mm. longus, tenuissime pubescens, dentibus late triangularibus. *Petala* glabra; vexilli lamina rotundata, in unguem brevem acuminata, ecallosa; alæ carinæque petala subfalcata. *Stamina* monadelpha, vexillare solutum. *Discus* obliquus, brevis. *Ovarium* lineare, longe stipitatum, glabrum, multiovulatum. *Legumen* stipitatum, lineari, subtorulosum, glabrum, 8 cm. longum, 6–8 mm. latum, 6–8-spermum. *Semina* compressa, lentiformia, hilo elliptico prominente notata; testa chartacea, brunnea; radicula conica, supra cotyledonum commissuram prona.

Flowers July–August.

JAPAN : *Herb. Siebold* (*type*), *Oldham*, 386, *C. Wright* ; Nagasaki, *Maximowicz*, *Oldham*, 801 (climber in woods) ; Moji, *Hongkong Herb.* 8527.

A favourite Japanese garden creeper called *Kofusi* or *Kohusi*. It is fairly common also in hedges and wood-borders, sometimes covering the trees with masses of white flowers during July and August.

14. M. RETICULATA, *Benth. in Miq. Pl. Jungh.* 249 ; *Hance in Journ. Linn. Soc., Bot.* xiii. (1872) 101 ; *Forbes et Hemsl. l. c.* xxiii. (1886) 159 ; *Diels in Engl. Bot. Jahrb.* xxix. (1900) 412 ; *Dunn and Tutcher, Fl. Kwangt.* 76 ; *Ito et Matsum. Tent. Fl. Lutchu*, 136.—M. cognata, *Hance in Journ. Bot.* xviii. (1880) 260. M. purpurea, *Yatabe in Bot. Mag. Tokyo*, vi. 379, t. 12.

Frutex scandens, cortice pallido fibroso. *Folia* 3(–4)-juga, 10–20 cm. longa, petiolo 4-plo longiora, rachi glabra ; stipulæ persistentes, lineares, glabræ, 3 mm. longæ ; foliola superiora lateralia ovato-oblonga vel rarius ovata, obtusa vel obtuse acuminata, emarginata, 3–10 cm. (sæpius 5–6 cm.) longa, chartacea, supra subnitentia, utrinque crebre reticulata, glabra, nervis marginem propinquantibus sæpius 6-paribus erecto-patentibus ; petioluli 2 mm. longi ; stipellæ setaceæ, 1–2 mm. longæ. *Panicula* terminalis, 10–20 cm. longa, ad basin ramosa, rachi ut ramis in apice sæpius omnino velutina ; rami floriferi patentes, 6–12 cm. longi, sessiles, bracteis cum stipulis conformibus basi suffulti, primo caudati. *Flores* approximati, tamen singuli, 1·3–1·7 cm. longi ; pedicelli 3–5 mm. longi, puberuli ; bracteæ anguste lineari-lanceolatæ ante anthesin deciduæ. *Calyx* late campanulatus, 3–4 mm. longus, 5 mm. latus, præter marginem sæpius fere glaber, dentibus tubo 4–5-plo brevioribus ovatis ; bracteolæ persistentes, lanceolatæ, bis calyce breviores. *Petala* glabra, purpurea vel rosea ; vexilli lamina ovata, basi ecallosa, in unguem 3-plo breviorem subito angustata ; alarum laminæ basi cuneatæ ; carinæ laminæ basi fortiter falcatæ. *Stamina* diadelpha, vexillare solutum. *Discus* tubulosus, 1 mm. longus. *Ovarium* lineare, ad basin angustatum, multiovulatum, glabrum. *Legumen* lineare, ad 15 cm. longum, 1·5 cm. latum, facile dehiscens, valvis elasticis sublignosis primo inter semina cohærentibus. *Semina* 3–6, oblongo-lenticularia.

Flowers summer ; fruits autumn and winter.

CHINA : *Millett* (*type*), *Carles*, and *Bullock* (Fengwanshan) ; Kwangtung, *Staunton*, *Ford*, 43, 36, 37, *Hongkong Herb.* 9397 (N. River), *Henry*, 8392 (Hainan) ; Fokien, *Fortune*, A 95 (*type*), *Hongkong Herb.* 2588 (Foochow shores) ; Hongkong, *Hongkong Herb.* 1754 (Aberdeen and Repulse Bay), *Lamont*, 161 A (Pokfulam), *Tutcher* (Tytam), *Hance*, 1489 (Tytam Tuk), *Ford*, 10 (Lantao Island), *Hongkong Herb.* 9898 (Lantao) ; Formosa, *Faurie*, 146 (Mt. Taitum), 164 (Mokuto), *Oldham*, 158, *Wilford*, 462 (E. Coast), *Hongkong Herb.* 6860 (Hokuto), *Playfair*, 120 (Apes Hill, Takow), *Swinhoe*,

1489, *Henry*, 894 (Bankinsing); Kiangsi, *Forbes*, 122, and *Shearer* (Kiukiang), *Wilson*, 1648 (Kiukiang plain); Hupeh, *Henry*, 631 (Ichang), 1554 A, 2280, 2411 (Patung District), *Wilson*, 1017 (Patung); Chekiang, *Forbes*, 862 (Ningpo District), *Faber* (Ningpo); Luchu Islands (*fide* Yatabe), *Fortune*, 68.

A common and very beautiful climber in hedges, wood-borders, and rough stony slopes in many parts of S.E. China. The flowers are dark purple to dark red in the coastal regions, purple or rose in the interior: the former kind dries almost black in flower and leaf; the latter, which maintains its colour and has, moreover, a more downy inflorescence, has been distinguished by Hance under the name of *M. cognata*, but with the abundant material now available it is impossible to regard it as distinct from *M. reticulata*.

15. M. EURYBOTRYA, *Drake in Morot, Journ. de Bot.* v. (1891) 187.

Frutex scandens, cortice striato, fusco. *Folia* ramorum floriferorum omnino glabra, (2–)3-juga, 20–25 cm. longa, petiolo 4-plo longiora; stipulæ lanceolatæ, basi in auriculam productæ; foliola lateralia superiora oblonga, obtuse acuminata, basi rotundata, chartacea, opaca, venulosa, venis marginem appropinquantibus 5–6-paribus arcuatis infra prominentibus; petioluli 2–3 mm. longi; stipellæ setaceæ, 2 mm. longæ; folia ramorum sterilium similia sed longiora; foliola longiora, angustiora, basi magis cuneata. *Panicula* terminalis, pedunculata, 20–40 cm. longa, rachi ut pedicellis calycibusque dense puberula; rami longi, patentes, basi stipuliferi. *Flores* approximati sed singuli, 1·4–1·5 cm. longi; pedicelli 4–5 mm. longi; bracteæ linerares, 1–2 mm. longæ, persistentes. *Calyx* campanulatus, 4 mm. longus et latus, dentibus brevibus rotundatis; bracteolæ 2, bracteis similes. *Petala* rosea, glabra; vexilli lamina fortiter reflexa, rotundata, ungui 4-plo longior, basi paullo transverse callosa; alæ basi utrinque subfalcalæ; carinæ petala basi truncata. *Stamina* diadelpha. *Discus* brevis, tubulosus. *Ovarium* lineare, basi in stipitem brevem angustatum, glabrum, multiovulatum. *Legumen* 4–11 cm. longum, 3 cm. latum, nonnunquam inter semina constrictum, apice basique obtusum, marginatum, glabrum, facile dehiscens; valvæ coriaceæ inter semina leviter cohærentes. *Semina* 1–4, compressa, 2·5 cm. longa, 2 cm. lata, 6 mm. crassa.

COCHIN CHINA: Tonkin, Tu Phap, *Balansa*, 2300, 2303–4 (*types*), 2302 (Banks of Black River, *type*).

16. M. SPECIOSA, *Champ. in Kew Journ. Bot.* iv. (1852) 73; *Benth. Fl. Hongk.* 78; *Forbes and Hemsl. in Journ. Linn. Soc., Bot.* xxiii. (1886) 159; *Dunn and Tutcher, Fl. Kwangt.* 76.—M. nitida, *Drake in Journ. de Bot.* v. 187, non *Benth.*

Frutex procumbens, ramis velutinis tandem glabrescentibus, siccitate nigris.

Folia (5–)6-juga, 15–20 cm. longa, petiolo 6–7-plo longiora, rachi pubescenti, glabrescenti ; stipulæ angustæ, lanceolatæ, 3–4 mm. longæ, persistentes ; foliola lateralia superiora oblongo-lanceolata, breviter et obtuse acuminata, basi rotundata, 5–6(–9) cm. longa, chartacea, supra glabra, nitentia, infra puberula, in siccitate fuscescentia, margine revoluto, venis marginem propinquantibus 5–6 paribus inter se arcuatis fere patentibus haud prominentibus ; petioli 1–2 mm. longi ; stipellæ setaceæ, 2–3 mm. longæ. *Racemi* sæpius axillares, nonnunquam paniculam foliosam terminalem formantes, ad 30 cm. longi, sessiles, rachi velutina. *Flores* primo approximati, caudam pendulam formantes, anthesi singuli, 2·8–4·5 cm. longi ; pedicelli 1·2 cm. longi, ut calyces et rachis velutini, apice bibracteolati ; bracteæ lanceolatæ, 5 mm. longæ, deciduæ ; bracteolæ ovatæ, calycis tubo 2–3-plo breviores. *Calyx* campanulatus, 1·3 cm. longus, 1 cm. latus ; dentes 4, superiore late ovato bilobato, cæteris ovatis rotundatis vel infimo acuto, tubo 3-plo breviores. *Petala* glabra, eburnea ; vexillum ovatum, basi bicallosum, in unguem subito contractum ; alæ basi utrinque truncatæ vel falcatæ ; carinæ petala in latere superiore falcatæ. *Stamina* diadelpha, vexillare solutum. *Discus* tubulosus, 1–2 mm. longus. *Ovarium* stipitatum, velutinum, multiovulatum. *Legumen* 9–13 cm. longum, 1–2 cm. latum, dense velutinum, elastice dehiscens ; valvæ lignosæ, inter semina cohærentes. *Semina* 4–6, ovata.

Flowers July to October, fruits February.

COCHIN CHINA : Tonkin, *Balansa*, 1205, 2230 (Bat-Bac).

CHINA : *Millett* ; Kwantung, *Henry*, 8341 (Hainan), *Hongkong Herb.* 6631 (Hainan, Ng Chi Shan) ; Hongkong, *Champion*, 505, 261 (*types*), *C. Wright*, 138. *Hongkong Herb.* 2011 (Bowen Road), *Lamont*, 160 (Pokfulam, Robinson Road, and Happy Valley Woods); Hongkong New Territory, *Hongkong Herb.* 9341, 4806 (Kanghau), 1181 (Ha Hang).

IC. INED. *Eyre* (Libr. Kew).

60125 17. M. FORDII, *Dunn*, sp. n.

Frutex scandens, præter inflorescentiam glaber. *Folia* 3-juga, 10–20 cm. longa, petiolo 5-plo longiora ; stipulæ setaceæ, 4–5 mm. longæ, persistentes ; foliola lateralia superiora lineari-lanceolata, in acumen longum obtusum angustata, basi rotundata, 4–8 cm. longa, papyracea, utrinque subnitentia, venis marginem appropinquantibus 5–6-paribus fere patentibus inter se anastomosantibus haud prominentibus ; petioluli 1–2 mm. longi ; stipellæ 3 mm. longæ, persistentes, setaceæ. *Racemi* sæpius terminales, nonnunquam cum aliis axillaribus paniculam terminalem formantes, fere sessiles, 5–7 cm. longi, rachi velutina. *Flores* approximati sed singuli, primo racemum brevem obtusum formantes, 1·8–1·9 cm. longi ; pedicelli 4–6 mm. longi, ut calyces et raches velutini, apice bibracteolati ; bracteæ lanceolatæ, 3 mm. longæ, deciduæ ; bracteolæ ovatæ, calycis tubo 3-plo breviores. *Calyx* campanulatus, 8 mm. longus, 5 mm. latus, dense sericeus, dentibus 4, tubo 3–4-plo brevioribus, superiore rotundato bifido, aliis triangularibus, infimo paullo longiore. *Petala* glabra ; vexilli lamina ovata, basi leviter bicallosa, in unguem 3–4-plo breviorem subito angustata ; alæ hastatæ ; carinæ petala profunde falcata. *Stamina* diadelpha. *Discus* tubulosus. *Ovarium* longe stipitatum, multiovulatum.

CHINA : Kwantung, *Ford*, 62 (Lienchow River).

60142 18. M. OOSPERMA, *Dunn*, sp. n.

Frutex alte scandens vel late vagans, ramis primo velutinis mox glabris, cortice lævi glabro. *Folia* 2-juga, 25–40 cm. longa, petiolo 4-plo longiora, rachi puberula; stipulæ setaceæ, deciduæ; foliola superiora lateralia lanceolata vel ovato-oblonga, apice breviter obtuse acuminata, acuta vel rotundata apiculata, basi cuneata vel rotundata, 8–20 cm. longa, chartacea, supra glabra vel sparse hirsuta, nitentia, subtus molliter hirsuta, venis marginem appropinquantibus 7–12-paribus, subtus prominentibus nonnunquam reticulatis, supra paullo impressa ; petioluli 4–5 mm. longi ; stipellæ setaceæ, 2–3 mm. longæ. *Panicula* terminalis, infra nonnunquam foliata, 10–20 cm. longa, rachi breviter velutina. *Flores* approximati singuli, 1·5–1·7 cm. longi ; pedicelli 5 mm. longi, ut calyces breviter velutini. *Calyx* campanulatus, 6 mm. longus, 4 mm. latus, dentibus tubo æquilongis paullo bilabiatis, superiore bidentato, cæteris rotundatis ; bracteolæ 2 mm. longæ, lineares. *Petala* rubida ; vexilli lamina rotundata, basi paullo callosa et inflexo-auriculata, ungue 3-plo longior, dorso dense sericea ; alæ utrinque falcatæ ; carinæ petala paullo falcata. *Stamina* diadelpha, vexillare solutum. *Discus* brevis, tubulosus. *Ovarium* lineare, pubescens, multiovulatum. *Legumen* oviforme si monospermum, cylindricum, inter semina constrictum, si polyspermum, 6–13 cm. longum, 2–2·5 cm. latum, 2 cm. crassum, velutinum, tarde dehiscens, valvis lignosis (?) inter semina cohærentibus. *Semina* 2–3, oviformia, 3 cm. longa, basi truncata ; radicula brevis, erecta, inclusa.

Flowers in the summer, fruits in winter.

CHINA : Yunnan, *Henry*, 12992 A (Szemao forests), 10265, 10670, 10670 B, 10670 C ; Kwangsi, *Wenyon, Morse*, 294, 648 (Lungchow) ; Kwangtung, *Henry*, 8235 (Hainan), *Ford*, 371 (Hainan) ; Hongkong, *Hongkong Herb.* 1428 (Cape d'Aguilar).

Henry has noted on Morse's Lunchow specimen : "a kind at Canton said to have an edible seed."

19. M. DORWARDI, *Coll. et Hemsl. in Journ. Linn. Soc., Bot.* xxviii. (1890) 40.

Frutex magna, scandens, (vel arbor ?), novellis dense pubescentibus, cortice brunneo scabro. *Folia* 2-juga, 15–25 cm. longa, petiolo 4-plo longiora, rachi tenuiter hirsuta ; stipulæ lineares, 4–5 mm. longæ, tarde deciduæ ; foliola superiora lateralia ovata vel ovato-oblonga, obtusa vel obtuse breviter acuminata, basi obtusa, 6–11 cm. longa, chartacea, utrinque glabra, reticulata, venis marginem appropinquantibus 6–9-paribus, infra prominentibus; petioluli 3–5 mm. longi; stipellæ setaceæ, 2–2·5 mm. longæ. *Panicula* terminalis, robusta, 12–18 cm. longa, rachi ut ramis pedicellis calycibus dorsisque vexillorum dense adpresse sericea; ramuli floriferi multiflori. *Flores* singuli, sæpe verticillatim dispositi, 1·8–2·3 cm. longi; pedicelli 5 mm. longi. *Calyx* campanulatus, dentibus brevibus late rotundatis. *Vexilli* lamina rotundata, basi breviter cordata ob basin utrinque inflexam, ungue 3-plo longior; alæ breviores utrinque falcatæ; carinæ petala valde falcata. *Stamina* diadelpha. *Discus* tubulosus, brevis, crenulatus. *Ovarium* lineare, pubescens, multiovulatum. *Legumen* nondum maturum oblongum, turgidum, 9 cm. longum, 3 cm. latum, 1 cm. crassum, velutinum, 2-spermum.

Flowers in May, fruits in October.

UPPER BURMA: Kachin Hills, Bhamo, *Cubitt*, 51 (6000 ft.), 288, 332 (Sinlum at 5750 ft.); Maymyo, *Lace*, 5797, 5849.

SHAN STATES: Khoni, *Prazer*, *Collett*, 759, 773 (*types*), *Abdul Khalil* (Saikaw).

Native name (Kachin) *Noibau Ru*.

20. M. CINEREA, *Benth. in Miq. Pl. Jungh.* 249; *Baker in Hook. f. Fl. Brit. Ind.* ii. 106; *Kurz, For. Fl. Brit. Burma*, 353.—Pongamia cinerea, *Grah. in Wall. Cat.* n. 5888. P. palustris, *Grah. in Wall. Cat.* n. 5889. P. paniculata, *Grah. l. c.* 5904. P. heterocarpa, *Wall. ex Baker, l. c.* P. oblonga, *Grah. l. c.* 5893.

Frutex scandens, ramis glabris primo lævibus tandem rugosis. *Folia* sæpissime bijuga, 15–25 cm. longa, petiolo 4-plo longiora, rachi tenuiter adpresse sericea glabrescente; stipulæ caducæ; foliola superiora lateralia oblongo-obovata, breviter acuminata, basi rotundata, subcordata, 9–13 cm. longa, chartacea, præter venas infra pubescentes glabra, reticulata, venis 7–9-paribus infra prominentibus; petioluli 3 mm. longi; stipellæ setaceæ, 4–5 mm. longæ. *Panicula* terminalis, basi paullo foliata, 10–15 cm. longa, rachi ramis pedicellis calycibusque breviter dense adpresse hirtis; rami floriferi graciles, patentes, ad 6 cm. longi. *Flores* singuli vel 2–3-nim verticillati, 1·2–1·5 cm. longi; pedicelli 3–4 mm. longi; bracteæ triangulares, 1 mm. longæ, persistentes; bracteolæ lineares, 2 mm. longæ. *Calyx* campanulatus, 2·5–3 mm. longus, tenuiter hirsutus, dentibus triangularibus tubo 3–4-plo brevioribus, 3 inferioribus approximatis, superiore bidentato. *Petala* rubida, extus cuprea; vexilli lamina ovata, basi paullo incrassata, rotundata, ungue 6-plo longior, dorso dense pubescens; alæ supra falcatæ; carinæ petala subfalcata. *Stamina* diadelpha, vexillare solutum ad unguem vexilli nonnunquam cohærente. *Discus* obliquus, crenulatus, supra 1·5 mm., infra 1 mm. longus.

Ovarium lineare, pubescens, 5–7 ovulatum, breviter stipitatum. *Legumen* ad 13 cm. longum, 2 cm. latum, 1·5 cm. crassum, velutinum, ad semina turgidum et inter ea constrictum, tarde dehiscens, valvis coriaceis.

Flowers February to July, fruits September to January.

EAST HIMALAYA: Sikkim, *Griffith, Kew Dist.* 1786 (Darjeeling?), *Kurz*, 121 (Nagree), *Hooker* (1000–4000 feet), *King* (1800 feet), 871 (1000 feet), 833 (3000 feet), 2423 (Ryang at 1800 feet), 4826 (2500 feet) (1400 feet), *King's Collector* (3500 feet), *Lister* (Teesta and Ryang Valleys), *Gamble*, 492 C (Chumbati at 2000 feet), 2105 (Darjeeling), 2107 A, 9844 (Darjeeling at 3000 feet), 10525 (4000 feet), *Clarke*, 27976 D (*Teesta*), 11850 G (Rishap at 3000 feet), *Searlight*, 219 (Chumbi Valley); Buxa ("Bootan"), *Griffith*, 1176 (Kew Dist. 1948); Bhutan, *King*.

BENGAL: *Griffith, Kew Dist.* 1766 (E. Bengal); Chittagong, *Lister*, 402, *King's Collector*, 60, 541, 384, *Wall. Cat.* 5888 (Chittagong, *type*).

ASSAM: *Jenkins, Mann, King's Collector*; Khasia Hills, *Griffith, Kew Dist.* 1785, *Hook. f. et Thoms.* 2399 (2000–4000 feet), *Kunth* (Silhet), *Kurz*, 204 (3000–5000 feet), *Lobb* (1500 feet), *Lemann*, 359, *Wall. Cat.* 5888 (Silhet, *type*), *Clarke*, 11850, 40235 B (Mairung at 5000 feet), 40310 (Shillong at 4500 feet), 44038 C (3500 feet), 44106 A (Shillong at 5200 feet), *Gallatly*, 701 (at 3000 feet), 383 (at 5000 feet); British Bhutan, *Prain*; Cachar, *Craib*, 409 (Haflang at 2500 feet), *Prazer*; Manipur, *Watt*, 5032 (at 2000 feet); Lushai Hills, *Leslie*, 340 (at 4000 feet).

UPPER BURMA, *King's Collector*, 38, *Aubert and Gage* (Minbu).

SHAN STATES, *MacGregor*, 803.

CALCUTTA BOTANIC GARDEN, *Hort. Bot. Calc.* 233, *Wall. Cat.* 5887, 5888, 5888 A ("Hab. Silhet"), 5889, 5893, 5904.

IC. INED. *Roxb.* 2534 (Libr. Kew).

21. M. SERICOSEMA, *Hance in Journ. Bot.* xx. (1882) 259.

Frutex scandens?, cortice rubido, ramulis ferrugineo-tomentosis. *Folia* 2-juga, 13–15 cm. longa, petiolo 6–7-plo longiora, stipulæ setaceæ; foliola lateralia superiora lanceolata, acuta, basi obtusa, 6–7 cm. longa, supra glabra, opaca, reticulata, subtus dense ferrugineo-tomentosa, venis infra prominentibus; stipellæ setaceæ. *Panicula* terminalis, 8–10 cm. longa, rachi dense fulvo-velutina. *Flores* confertissimi, singuli, 1·7 cm. longi; pedicelli 2 mm. longi. *Calyx* campanulatus, 4–5 mm. longus, fulvo-tomentosus, dentibus 4, superiore oblongo-bifido, lateralibus anguste lanceolatis, inferiore tubo æquilongo cæteris longiore; bracteolæ lanceolatæ, breves. *Petala* purpurea; vexilli lamina ovata, basi ob marginem juxta unguem utrinque paullo inflexa subcordata, ungue 3–4-plo longior, dorso densissime cinerascens sericea; alæ breviores, subfalcatæ; carinæ petala arcuata, subfalcata. *Stamina* diadelpha. *Discus* crenulatus, tubulosus, 1 mm. longus. *Ovarium* stipitatum, fulvo-pannosum, multiovulatum.

CHINA: Szechuen, *E. H. Parker* (in 1881), *Hance, Herb. Propr.* 21961.

Only one specimen known (British Museum Herbarium). Hance referred it to § *Otosema* on account of the subcordate standard.

22. M. DIELSIANA, *Harms ex Diels in Engl. Jahrb.* xxix. (1900) 412; *Dunn and Tutcher, Fl. Kwantung*, 76.—M. Bockii, *Harms, l. c.* M. Duclouxii, *Pamp. in Nuov. Giorn. Bot. Ital.* N. S. xvii. (1910) 25. M. cinerea, *Benth., var.* yunnansis, *Pamp. l. c.* M. cinerea, *Franch. Pl. David.* ii. 32 (non *Benth.*?). M. ?, *Forbes et Hemsl. in Journ. Linn. Soc., Bot.* xxiii. (1886) 159.

Frutex scandens vel sæpius longe procumbens, cortice fusco striato. *Folia* sæpissime 2-juga, 15–30 cm. longa, sæpius glabra; stipulæ lineares, 3 mm. longæ, deciduæ; foliola lateralia superiora sæpius lanceolata, gradatim acuta vel breviter acuminata, apice obtusa, basi obtusa vel rotundata vel etiam subcordata, 5–15 cm. longa, chartacea, supra subnitentia, rarius rugosa, venis marginem appropinquantibus 6-paribus erecto-patentibus supra impressis infra prominentibus; petioluli 2–3 mm. longi; stipellæ setaceæ, persistentes, 3–5 mm. longæ. *Panicula* terminalis in magnitudine formaque late variat, aliquot parva erecta, ramis brevibus patentibus, aliquot magna pendula, ramis longis flabelliformibus, ad 40 cm. extensa, basi foliosa, rachi plus minus dense pubescente; rami ad basin floriferi, bracteis stipuliformibus suffulti. *Flores* fragrantes, approximati, 1·2–2·4 cm. longi, pedicellis 3–4-plo longiores; bracteæ setaceæ, persistentes. *Calyx* late campanulatus, 3–5 mm. longus, 4–6 mm. latus; ut pedicelli sæpissime tenuiter pubescens, dentibus 4, superiore late ovato emarginato, cæteris ovatis vel lanceolatis, tubo 3-plo brevioribus, bracteolæ lineares, tubo calycis duplo breviores. *Vexilli* lamina ovata, ante anthesin recurvata, apice emarginata, basi truncata, subcordata, juxta unguem minute inflexa, intense rubra, extus dense sericea, ungui 3-plo longior; alæ breviores utrinque subfalcatæ; carinæ petala basi truncata. *Stamina* diadelpha, vexillare liberum ima basi dilatatum. *Discus* brevissimus. *Ovarium* sericeum, stylo glabro æquilongo. *Legumen* lineare, 7–12 cm. longum, 1·5–2·0 cm. latum, facile dehiscens, velutinum, valvis lignosis, inter semina cohærentibus. *Semina* 3–4, oblonga, compressa, 8 mm. longa, 6 mm. lata, 2 mm. crassa.

Flowers through the summer, fruits in autumn and winter.

CHINA: Yunnan, *Henry*, 9633 (Red River), 10813 (Mengtze), *Maire*, 163 (Yunnan-sen Mts.), *Ducloux*, 375 (Cheng Tong Han), 384, 389; Kwangsi, *Morse*, 582 (Lungchow); Kwangtung, *Hongkong Herb.* 1799, 5059, and 9394 (Lienchow River), *Ford*, 63 (Lofoushan); Hongkong, *Wright*, 137; Hongkong New Territory, *Ford*, 645 (Taimoshan), *Hongkong Herb.* 4805 (Kanghau), 7094 (Taimoshan); Fokien, *Fortune*, 17 (Foochow Mnts.), *Hongkong Herb.* 2579 (Yenping hills); Chekiang, *Barchet*, 128; Hupeh, *Henry*, 1584 (Ichang), 1938 (Nanto), 2561, 2917, 3074; Szechuen, *Faber*, 757 and 773 (Wushan), 758, 774 (Omie), *Wilson*, 824, 1089, 3412, 3412 A,

3413, 4834, *David* fide *Franchet?* (Moupine), *von Rosthorn*, 1626, 1638 (Nanchuan), "M. Bockii" (Nanchuan).

As described and cited above, the species comprises a large number of forms passing gradually one into another and corresponding in no marked degree to any special areas. It cannot be ascertained that they are due to variations of soil, climate, altitude, nor maritime influence, and with the ample material and notes which have passed through my hands I am obliged to regard it as a species which varies casually throughout the whole of its large area. Any attempt to segregate it at the present time into systematic groups is therefore without value in the field or herbarium. Under these circumstances it is not unexpected that botanists who have had to deal with isolated specimens have frequently described them as representing new species.

The first specimens to reach Europe were probably those gathered by Fortune among the hills near Foochow, on the S.E. coast of the empire. Bentham referred them doubtfully to *M. cinerea,* and it was not until half a century later that the specimens of the present common Chinese climber now accumulated in large numbers in European herbaria were seen to be distinct from that species. They are now brought together under the name of the first form to be separately described, *M. Dielsiana.* As may be gathered from the description, it is remarkably variable in size of flowers, length of panicle branches, and in the pubescence of its leaves and stem, and in certain states it bears a close superficial resemblance to allied species. Thus when the leaves are glabrous and reticulate it can be distinguished from *M. cinerea* only by its pods, and from *N. nitida* by the slender character of its panicle and flowers; when the leaves are pubescent its fruit alone certainly distinguishes it from *M. oosperma.*

23. M. NITIDA, *Benth. in London Journ. Bot.* i. (1842) 484; *in Miq. Pl. Jungh.* 249; *Benth. in Fl. Hongk.* 78; *Forbes et Hemsl. in Journ. Linn. Soc., Bot.* xxiii. (1886) 159; *Dunn and Tutcher, Fl. Kwangt.* 76.—Marquartia tomentosa, *Vogel in Nov. Act. Nat. Cur.* xix. Suppl. I. (1843) 35.

Frutex volubilis alte scandens, cortice fusco rugoso, ramis primo adpresse sericeis glabrescentibus. *Folia* bijuga, 15–20 cm. longa, petiolo 5-plo longiora, præter vestigia indumenti decidui maturitate glabra; stipulæ lineares, 1–2 mm. longæ; foliola lateralia superiora lanceolata, gradatim acuminata, basi rotundata vel obtusa, chartacea, utrinque nitida, reticulata, venis marginem appropinquantibus 5–6-paribus infra prominulis; petioli 2–3 mm. longi. *Panicula* terminalis, 6–10 cm. longa, rachi adpresse sericea; rami floriferi patentes, 6–10 cm. longi. *Flores* approximati, singuli, 1·9 cm. longi; pedicelli 2–3 mm. longi, ut calyx vexillique dorsum dense sericeo-velutini; bracteæ lanceolatæ, caducæ. *Calyx* campanulatus, 6 mm. longus, 5 mm. latus, dentibus 4, superiore late rotundato emarginato, 3 inferioribus tubo

paullo brevioribus anguste triangularibus apice rotundatis. *Vexilli* lamina forte reflexa, basi callosa, auriculis attingentibus stamen vexillare amplectentibus, extus alba, intus intense violascens; alæ breviores, basi hastatæ; carinæ petala in unguem angustata. *Stamina* diadelpha. *Discus* brevissimus. *Ovarium* lineare, velutinum, multiovulatum. *Legumen* 10–14 cm longum, 1·5–2 cm. latum, velutinum, facile dehiscens; valvis tenuiter lignosis, inter semina cohærentibus. *Semina* 4–5, 1 cm. longa, 8 mm. lata, 2 mm. crassa.

Flowers in summer and autumn, fruits in winter.

CHINA: Hongkong, *Millett (type)*, *Wilford*, 146, *Hinds (type)*, *Champion*, *Urquhart*, *Hongkong Herb.* 1903, *Hance*, *Forbes*, 592, *Lamont*, 158–9.

IC. INED *Eyre* (Libr. Kew).

This straggling or shortly climbing *Millettia* has not so far been found outside the island of Hongkong, though common there and one of the well-known ornaments of the uplands. During the winter months long leafless shoots are thrown out to a length of sometimes 15 feet along the ground, climbing, when circumstances permit, by means of a reflexed strigosity.

23 *a*. M. MEGASPERMA, *Benth. Fl. Austral.* ii. 211; *Bailey*, *Queensl. Fl.* ii. 396; *Cat. Queensl. Pl.* (1912) 138.—Wistaria megasperma, *F. von Muell. Fragm.* i. 10; *Moore*, *Fl. New South Wales*, 149.

Frutex alte scandens, præter novellas et inflorescentiam glaber, cortice lævi. *Folia* 3–6-juga, 15–20 cm. longa, petiolo 5-plo longiora; stipulæ lineares, persistentes, 5 mm. longæ; foliola superiora lateralia oblongo-lanceolata vel obovata, acuminata, basi cuneata, subcoriacea, lævia, venis marginem appropinquantibus 5–7-paribus obscuris; petioluli 2–3 mm. longi; stipellæ setaceæ, 2 mm. longæ. *Racemi* longi, laxiflori, in paniculam longam terminalem collecti, rachi breviter velutina. *Flores* singuli, 9 mm.–1·2 cm. longi, purpurei; pedicelli ad 1·3 cm. longi, graciles ut calyces, dorsumque vexilli breviter dense pubescentes; bracteæ ovatæ, acuminatæ, 3 mm. longæ, caducæ; bracteolæ lineares, caducæ. *Calyx* late campanulatus, 3–4 mm. longus, lobis tubo subequalibus, 2 superioribus in unum latum emarginatum connatis. Vexillum rotundatum, in unguem brevem latam contractum, basi transverse callosum; alæ oblongæ, basi uncinatæ; carinæ petala conformia. *Stamina* diadelpha. *Discus* brevis, cylindicus. *Ovarium* lineare, teres, stipulatum, sericeum, pluriovulatum. *Legumen* crassum, lineare, apice basique acuminatum, ad 18 cm. longum, 4 cm. latum, 3·5 cm. crassum, 4-spermum, breviter tomentosum, suturis haud incrassatis, dehiscens. *Semina* ovalia, 4 cm. longa, 3 cm. lata, 2·5 cm. crassa.

AUSTRALIA: Queensland, not uncommon in the southern scrubs (*fide* Bailey, *l. c.*); Upper Brisbane River, *Hill and Mueller*, Moreton Bay District, *G. M. Leay*; New South Wales, Richmond River, *C. Moore*.

CULTIVATED: Sydney and Hongkong Botanic Gardens.

23 *b*. M. AUSTRALIS, *Benth. in Miq. Pl. Jungh.* 250.—M. megasperma, *Hook. f. in Bot. Mag.* t. 6541, non *Benth.* M. Camerana, *F. v. Muell. in Journ. Bot.* xxiii. (1885) 353? M. Maideniana, *Bailey in Bot. Bull. Agric. Brisbane*, v. 12. Wistaria Camerana, *F. v. Muell. l. c.* W. Maideniana, *Bailey ex Moore in Fl. New South Wales*, 517; *Cat. Queensl. Pl.* 138, t. 110 (1912). Pterocarpus australis, *Endl. Prod. Norf.* 94.

Frutex alte scandens, caule tereti lævi striato primo breviter pubescente. *Folia* 6–13-juga, 10–20 cm. longa, petiolo 8-plo longiora, rachi pilis brevibus adpressis tenuiter pubescente; stipulæ lineares, 2 mm. longæ, caducæ; foliola superiora lateralia oblongo-lanceolata, ad apicem obtusam paullo angustata, basi rotundata, obliqua, 3·5–6 cm. longa, subcoriacea, margine angusta paullo revoluta siccitate fortiter utrinque reticulata, venis marginem appropinquantibus 7–10-paribus; petioluli 1–3 mm. longi; stipellæ setaceæ, 1–2 mm. longæ. *Racemi* axillares vel in paniculam terminalem 15 cm. longam dispositi, rachi ut pedicellis calycibus dorsoque vexilli breviter adpresse dense sericea. *Flores* singuli, 1·3–1·5 cm. longi, jasminodori; pedicelli 5–6 mm. longi; bracteæ lineares, acutæ, caducæ; bracteolæ conformes, 3–4 mm. longæ, caducæ. *Calyx* late campanulatus, sub-bilabiatus, 6 mm. longus, lobo superiore lato emarginato, 3 inferioribus lanceolatis acutis paullo brevioribus. *Petala* lilacina; vexillum rotundatum in unguem brevem subito angustatum, basi transverse callosum, tandem reflexum; alæ oblongæ, basi uncinatæ; carinæ petala oblongo-ovata, basi paullo hamata. *Stamina* diadelpha. *Discus* nullus. *Ovarium* lineare, sericeum, multiovulatum. *Legumen* ellipsoideum, turgidum, utrinque acutum, glabrescens, 9 cm. longum, 3·5 cm. latum; valvis lignosis. *Semina* 1·5–2·5 cm. diam., suborbicularia, 2 vel plura.

Flowers in October.

NORFOLK ISLAND, *Bauer*, *Isaac Robinson.*

QUEENSLAND: Port Macquarie (*fide* Bailey, *l. c.*).

CULTIVATED: Royal Botanic Gardens, Kew (Temperate House).

The species is not uncommon in Norfolk Island, where the dense tangles, formed largely by its tough stems, were a well-known obstacle to the early explorers. But fruit has rarely been found there. The description of the pod is taken from F. von Mueller's in the 'Journal of Botany' (1885, 353).

The seeds from which the plant grown at Kew was raised were contributed by that botanist many years before he received or described the pod from Norfolk Is., and were probably collected in Queensland when *M. megasperma* (which it resembles) was the only known *Millettia* in that country. This would account for its being sent to Kew and long cultivated there under that name.

23 *c*. M. PILIPES, *Bailey in 2nd Add., 3rd Suppl. Syn. Queensl. Fl.*; *Queensl. Fl.* ii. 397; *Cat. Queensl. Pl.* 138 (1912).

Frutex alte scandens, præter inflorescentiam glaber. *Folia* 2–3-juga, 15–20 cm. longa, petiolo 3–4-plo longiora; foliola superiora lateralia oblongo-lanceolata, 4–6 cm. longa, margine undulata, apice paullo angustata, obtusa, basi obtusa, coriacea, nitentia, venis marginem approximantibus 6-paribus obscure reticulatis; petioluli 4–6 mm. longi; stipellæ nullæ? *Paniculæ* terminales, 15–20 cm. longæ, rachi apice ut ramis floriferis pubescente; rami floriferi 4–5 cm. longi, basi nudi. *Flores* in dimidio superiore conferti, 1·2 cm. longi, rubido-brunnei, quisque fastigio lato bracteæ suffultus; bracteæ ovato-lanceolatæ, 1·5 cm. longæ, caducæ; pedicelli graciles, 2 cm. longi, pilis flavidis vestiti; bracteolæ anguste lineares, calyci fere æquilongæ. *Calyx* campanulatus, 5 mm. longus, præter marginem ciliatam glaber, dentibus tubo æquilongis lanceolatis acutis. *Vexillum* fere orbiculatum, in unguem attenuatum, basi transverse callosum, dorso sparse puberulum; alæ oblongæ, ut carinæ petala basi uncinatæ. *Stamina* diadelpha. *Discus* nullus (vel secus *Bailey*, brevis crenulatus). *Ovarium* lineare, tomentosum.

AUSTRALIA: Queensland, Johnstone River, *Bancroft*.

24. M. RACEMOSA, *Benth. in Miq. Pl. Jungh.* 249; *Baker in Hook. f. Fl. Brit. Ind.* ii. 105; *Prain in Journ. As. Soc. Beng.* lxvi. II. (1897) 359; *Cooke, Fl. Bomb.* i. 322; *Gamble, Manual Ind. Timb.* 233 (1902); *Talbot, For. Fl. Bomb.* i. 384, t.—M. pallida, *Dalz. in Journ. Linn. Soc., Bot.* xiii. (1872) 187. M. leiogyna, *Kurz in Journ. As. Soc. Beng.* xlii. II. 67; *For. Fl. Brit. Burma*, 351. Robinia racemosa, *Roxb. Fl. Ind.* iii. 329. Pongamia racemosa, *Grah. in Wall. Cat.* n. 5914. P. Corcor, *Grah. l. c.* 5891. Tephrosia racemosa, *Wight et Arn. Prodr.* i. 210. Wistaria pallida, *Dalz. et Gibs. Bomb. Fl.* 61. W. racemosa, *Dalz. et Gibs. l. c.*

Frutex scandens, cortice griseo scabro (*Roxb.*), ramis ut rachibus foliorum et racemorum bracteis calycibusque primo laxe flocculoso-tomentosis, mox glabris siccitate nigrescentibus. *Folia* 5–6-juga, 25–40 cm. longa, petiolo 4–6-plo longiora; stipulæ lineari-setaceæ, 1·0 cm. longæ, persistentes; foliola superiora lateralia obovato-oblonga, obtuse acuminata, basi rotundata, 4–10 cm. longa, papyracea, mox omnino glabra, venis marginem approximantibus 8-paribus infra paullo prominentibus; petioluli 2–3 mm. longi; stipellæ setaceæ, 2–4 mm. longæ. *Paniculæ* terminales, basi paullo foliatæ, 20–50 cm. longæ; rami floriferi (racemi) 10–20 cm. longi. *Flores* rubidi, singuli, sæpe in verticillos 2–3-floros plurimos collecti; bracteæ stipulis similes, persistentes; pedicelli 4–5 mm. longi. *Calyx* campanulatus, 4–5 mm. longus, margine ciliato, cæteroquin sparse hirtus, dentibus brevissimis. *Petala* glabra; vexilli lamina ovata, in unguem brevem abrupte contracta, ecallosa; alæ falcatæ; carinæ petala oblonga, valde falcata. *Stamina* diadelpha. *Discus* tubularis, 1·5 mm. longus, obliquus. *Ovarium* stipitatum, glabrum, multiovulatum. *Legumen* lineare, paullo torulosum, 10–25 cm. longum, 1–1·4 cm. latum, glabrum, dehiscens; valvæ tenuiter lignosæ; endocarpum separabile, papyraceum, inter semina cohærens. *Semina* distantia, 4–5, oblongo-ovalia, 1·0 cm. longa, 8 mm. lata.

Flowers May and June, fruits in January and February.

S. India : *Beddome*, 33, 1900, 1901, 1903 (Godavery jungles, etc.), *Ritchie*, 1719 ; Coimbatore, *Fischer*, 1412 ; Madras, *Gamble*, 18566, 16507, 18716, 13847 ; Concan, *Stocks* ; Bombay, *Dalzell* ; N. Canara, *Talbot*, 590.

Bengal, *Kurz* ; Orissa, *Gamble*, 9311.

Assam : West Duars, *Haines*, 783.

Upper Burma, *Shaik Mokim*, 1576.

Lower Burma : Pegu, *Kurz*, 1722 ; Tenasserim, *Gallatly*, 61.

Shan States, *Abdul Khalil.*

Siam, *Luang Vanpruk*, 188 (Phre, teak-forests).

Philippine Islands : Luzon, *Bureau of Science*, 1064 (Bosoboso, Rizal).

Cultivated : Hort. Bot. Cal., *Wall. Cat.* 5891, 5914, *Roxburgh* (type).

Ic. ined. : (1) *Dalz.*, (2) *Roxb.* (Libr. Kew).

The local name in the teak area of Siam, where the plant is common, is *Du Kua*. Gamble (*l. c.*) describes the bark and wood. The floral structure bears a striking resemblance to that of *Gliricidia.*

25. M. trifoliata, *Dunn*, sp. n.

Arbor 17 m. alta, præter folia novissima omnino glabra, cortice griseo lævi. *Folia* paullo post anthesin enata, sed usque ad anthesin proximam sæpe persistentia, unijuga, 12–20 cm. longa, petiolo 5-plo longiora ; stipulæ nullæ ; foliola lateralia oblonga, acuminato-caudata, basi obtusa, 10–12 cm. longa, chartacea, supra nitida, venis marginem appropinquantibus 10–11-paribus divergentibus inconspicuis ; petioluli 4–5 mm. longi ; stipulæ nullæ. *Racemi* axillares, ad basin floriferi, 4–6 cm. longi. *Flores* singuli vel per pares collaterales, 2 cm. longi ; pedicelli 1 cm. longi ; bracteæ bracteolæque nullæ. *Calyx* campanulatus, 1 cm. longus, membranaceus, sparse puberulus, dentibus 4, superiore ovato apice bifido, cæteris lanceolatis tubo æquilongis. *Petala* glabra, alba ; vexillum ovatum ; alæ anguste oblongæ, subfalcatæ ; carinæ petala basi truncata. *Stamina* diadelpha. *Discus* nullus. *Ovarium* lineare, longe stipitatum, glabrum, 4-ovulatum.

Flowers in February.

Upper Burma : Polaw, *Robertson*, 126.

This interesting species was discovered by Mr. W. A. Robertson, of the Indian Forestry Service, on the bank of a stream at 2000 feet elevation in February, 1910. The specimens were sent to Mr. Gamble, lately Conservator of Forests in the same service, by whom they were kindly lent to me for examination and description.

26. M. PODOCARPA, *Dunn*, sp. n.

Arbor statu fructifero omnino glabra, cortice lævi griseo. *Folia* 2-juga, 10–13 cm. longa, petiolo 6–7-plo longiora; stipulæ caducæ; foliola lanceolata, longe caudata, basi obtusa, 8–9 cm. longa, chartacea, supra micantia, venis marginem approximantibus 9–11-paribus, haud prominentibus; stipellæ nullæ. *Racemi* ad basin floriferi, 6–7 cm. longi; nodi floriferi parvi, globulares. *Legumen* 16·5 cm. longum, 2·5 cm. latum, stipite 1·5 cm. longo, 2 mm. crasso, 4-seminiferum, valvis lignosis flavidis lævibus.

Fruit ripe in December.

UPPER BURMA: Upper Chindwin, *Meebold*, 7823 (Byinbou).

27. M. PISCIDIA, *Wight*, *Ic.* t. 86.—Galedupa Piscidia, *Roxb. Fl. Ind.* iii. 240.

Arbor parva, cortice albo lævi (*Roxb.*). *Folia* 2–3-juga, 10–15 cm. longa, petiolo 5–6-plo longiora; stipulæ nullæ; foliola superiora lateralia anguste lanceolata, attenuata vel acuminata, caudata, basi cuneata vel obtusa, 7–10 cm. longa, chartacea, utrinque leviter reticulata, mox glabra, venis marginem approximantibus 7–9-paribus, infra prominentibus; petioluli 4 mm. longi; stipellæ nullæ. *Racemi* laxi, bini cum ramulo foliato axillares, sed sæpius post folii lapsum enati, 6–7 cm. longi, rachi pedicellisque fere glabris. *Flores* 1·3 cm. longi, 1–3-ni, distantes; pedicelli 8 mm. longi; bracteæ bracteolæque nullæ. *Calyx* campanulatus, 5 mm. longus, margine ciliatus, cæteroquin minute puberulus, membranaceus, dentibus obsoletis. *Petala* nivea, membranacea, glabra; vexilli lamina ovata, in unguem 5-plo breviorem acuminata; alæ oblongæ, fortiter falcatæ; carinæ petala oblonga, basi truncata. *Stamina* diadelpha. *Discus* nullus. *Ovarium* lineare, longe stipitatum, pubescens, 3–4-ovulatum. *Legumen* oblongum, apice sæpius acuta, basi in stipitem 1–2 cm. longum subito angustatum, ad 10 cm. (sine stipite) longum, 3·5 cm. latum, valvis fortiter coriaceis.

Flowers in July, fruits in the cool season (*Roxb.*).

BENGAL: *Griffith*, *Kew Distr.* 1768 (Mishmee).

ASSAM: *Griffith*, 67; Khasia, *Kurz*, 325 (3000–4000 feet), *Hook. f. et Thoms.*, 1724, *Schlagintweit*, 271.

CULTIVATED: Calcutta Bot. Gard., *Griffith*, *Roxburgh* (type).

IC. INED. *Roxb.* 2321 (Libr. Kew).

The name *Piscidia* is probably adopted from the name of a tropical American genus having similar uses for intoxicating fish; it should therefore be spelled with a capital letter. Roxburgh's own labels under the genera *Dalbergia* and *Galedupa* use a small letter.

28. M. ICHTHYOCHTONA, *Drake in Journ. de Bot.* v. (1891) 187.

Arbor 5–10 m. alta, decidua, præter inflorescentiam tandem omnino glabra, ramulis pallidis rugosis. *Folia* 3–4-juga, 14–17 cm. longa, petiolo 7-plo longiora; stipulæ nullæ; foliola superiora lateralia anguste oblonga, gradatim acuminata, basi cuneata, 6–8 cm. longa, chartacea, venis marginem approximantibus 6-paribus inconspicuis; stipellæ 0. *Racemi* sessiles, axillares vel rarius in ramulis terminales, 6–8 cm. longi, rachi tenuiter pubescente; nodi floriferi sessiles, 1–2-flori. *Flores* 1·5 cm. longi, albi; pedicelli 1·3 cm. longi, filiformes; bracteæ bracteolæque nullæ. *Calyx* campanulatus, 5–6 mm. longus, apice basique pubescens, lateribus fere glaber, dentibus 4, 3 inferioribus anguste triangularibus, superiore latiore apice bifido, tubo paullo brevioribus. *Vexilli* lamina ovata, exauriculata, ut cætera petala glabra, in unguem 4-plo breviorem gradatim angustata; alæ oblongæ, falcatæ; carinæ petala paullo arcuata, basi obtusa. *Stamina* monadelpha, vexillare basi solutum. *Discus* nullus. *Ovarium* stipitatum, biovulatum. *Legumen* anguste oblanceolatum, breviter falcatum, 9·5–17 cm. longum, ad 3·5 cm. latum, glabrum, facile dehiscens; valvæ tenuiter lignosæ, liberæ. *Semina* 1–2, fusca, complanata.

COCHIN CHINA: Tonkin, *Balansa*, 2236–7 (cultivated in the Muong villages at Tu Phap and at the base of Mt. Bavi, *types*).

The tree, which appears to be cultivated in fishing villages in Tonkin, is deciduous and becomes quite bare in August, when buds from the old leaf-scars develop into abundant racemes of white flowers. Later other buds in similar positions give rise to leafy shoots. The leaves remain until after the fruit is mature in the autumn.

29. M. BONATIANA, *Pamp. in Nuov. Giorn. Bot. Ital.* N. S. xvii. (1910) 24.

Frutex alte scandens; caules minores ut raches foliorum et racemorum, ut petioluli, pedicelli calycesque breviter dense tomentosi. *Folia* 5–6-juga, 30 cm. longa, petiolo 7–8-plo longiora; stipulæ lineares, 5 mm. longæ; foliola superiora lateralia ovato-acuminata, basi rotundata vel subcordata, 7–8·5 cm. longa, chartacea, primo utrinque dense sericeo-tomentosa, tandem fere glabra, opaca, venis marginem appropinquantibus 5–6-paribus infra prominulis; petioluli 3–4 mm. longi; stipellæ nullæ. *Racemi* axillares, 3·5–7 cm. longæ, pedunculo parti floriferæ æquilongo. *Flores* singuli vel bini, 2·5 cm. longi; pedicelli 10 mm. longi; bracteæ lineares, caducæ, 3 mm. longæ. *Petala* viridula; vexilli lamina ovata, in unguem brevem acuminata, exauriculata, dorso dense pubescens; alæ oblongæ, longe hamatæ; carinæ petala falcata. *Stamina* diadelpha. *Discus* obliquus tubulosus, 2 mm. longus. *Ovarium* lineare, stipitatum, pubescens, 4-ovulatum. *Legumen* lineare, fulvo-tomentosum, 10–11 cm. longum, 1·8 cm. latum. *Semina* ferruginea, 1·1 cm. lata.

Flowers in May and June, fruits in October.

CHINA: Yunnan, *Maire*, 156 (Yunnansen, *type*), *Morse*, 23, *Ducloux*, 810.

30. M. PACHYCARPA, *Benth. in Miq. Pl. Jungh.* 250; *Baker in Hook. f. Fl. Brit. Ind.* ii. 106; *Kurz, For. Fl. Brit. Burma*, 353; *Prain in Journ. As. Soc. Beng.* lxvi. II. (1897) 361; *Brandis, Ind. Trees*, 221; *Hook. Ic. Pl.* t. 2738.

Frutex alte scandens vel nonnunquam arbor, cortice fusco lenticellato, ramis primo velutinis, tarde glabrescentibus. *Folia* 6–8-juga, 30–50 cm. longa, rachi mox glabra; stipulæ persistentes, rotundatæ, 2–3 mm. longæ; foliola lateralia superiora oblongo-lanceolata, breviter acuminata, basi acuta vel obtusa, 14–16 cm. longa, chartacea, supra glabra, tandem nitentia, subtus adpresse sericea, tandem fere glabra, venis marginem appropinquantibus 12–15-paribus, erecto-patentibus, infra prominulis; petioluli 4–5 mm. longi. *Paniculæ* racemiformes 2–6, in novellis infra folia approximatæ, 15–30 cm. longæ, sessiles, rachi ut pedicellis calycibusque breviter adpresse brunneo-sericea; nodi floriferi rotundati, 1–3 mm. longi, bracteis 1–2 mm. longis ovatis suffulti. *Flores* in nodis 2–5-nim fasciculati, 2·1–2·3 cm. longi; pedicelli 1 cm. longi; bracteæ parvæ, ovatæ. *Calyx* campanulatus, 7 mm. longus, 6 mm. latus, dentibus 4, superiore obtuso bidentato, inferioribus triangularibus 3–4-plo tubo brevioribus; bracteolæ 1–2 mm. longæ. *Petala* glabra, pallide lilacina; vexilli lamina ovata, in unguem brevem subito contracta, ecallosa; alæ oblongæ, basi visu hamatæ; carinæ petala basi truncata vell eviter hamata. *Stamina* monadelpha, vexillare basi solutum inflexum. *Discus* nullus. *Ovarium* pubescens, multiovulatum. *Legumen* turgidum, oblongum vel (si monospermum) oviforme, plus minus inter semina constricta, ad 23 cm. longum, 5 cm. latum et 3 cm. crassum, suturis incrassatis, glabrum, tuberculatum, valvis lignoso-coriaceis tarde dehiscentibus. *Semina* 1–5, ad 3 cm. longa, 2·5 cm. lata et 2 cm. crassa, reniformia.

The racemes and leaves develop together in April, the flowers expanding in May. The fruit is half-grown and the leaves mature and becoming glabrous in June. The ripe fruit in November.

EAST HIMALAYA: Sikkim, *Kurz*, *Hook. f.* (1000–3000 feet), *King* (2000 feet), *King* and *Lister* (Ryang Valley), *Gamble* 765 A, C (Selimpahar), *Prain's Collector*, 438 (Mangpoo), *Gamble*, 1103 A, 2102 A (Darjeeling).

BENGAL: W. Duars, *Gamble*, 6669 B; Chittagong, *Herb. Rep. Ec. Prod.* 26072, *Hook. f. et Thoms.*

ASSAM: *Jenkins* (type), *Griffith*, *Kew Dist.* 1767, *Kurz*, 142, *Clarke*, 43242 C, *King's Collector*; Khasia Hills, *Mann* (4000–5000 feet), *Kurz*, 306, *Clarke*, 43280 B (Nungpo), 17739 A, 44208 (Shillong), *Herb. Rep. Ec. Prod.* 12062, 12415, 10263 (Karimgunge), *Hook. f. et Thoms.*; Cachar, *Keenan*; Manipur, *Watt*, 7257, *Kuntze*, 5564; Naga Hills, *Prazer*, 7, *Meebold*, 7123 (Phalang at 5000 feet).

UPPER BURMA: *Anderson* (Poneshee), *Prazer* (Khoni), *Dun*, 103 (Chin

Hills), *Shaik Mokim* (Kachin Hills), *Lace*, 3289 (Maimyo), *Herb. Rep. Ec. Prod.* 29928 (Bhamo).

LOWER BURMA : Tenasserim, *Gallatly*, 725.

CALCUTTA BOTANIC GARDEN, *Kurz* ("Pongamia multijuga").

SIAM : Doi Sutep, *Kerr*, 1770.

CHINA : Yunnan, *Henry*, 10521 (Mengtze), 13000 and 13530 (Szemao) ; Szechuen, *Wilson*, 3414 ; Fokien, *Herb. Hongkong*, n. 2564 (Yenping).

IC. INED. *Cathcart* (Libr. Kew).

Aberrant from the great bulk of *Millettia* by reason of its large seeds and soft, tardily dehiscent pod-valves. *M. cinerea*, however, which has similar pods, connects it with the normal-podded *M. Dielsiana*. It bears a close superficial resemblance when in flower to *Derris elliptica*, which has, however, its standard densely silky not glabrous on the back.

Brandis gives (*l. c.*) the Khasi vernacular name as *Kharina*.

31. M. SERICEA, *Benth. in. Miq. Pl. Jungh.* 248 ; *Miq. Fl. Ned. Ind.* i. 153 ; *Baker in Hook. f. Fl. Brit. Ind.* ii. 104 ; *Prain in Journ. As. Soc. Beng.* lxvi. II. (1897) 88 ; *Koorders, Excursionsfl. Java*, ii. 382.—Pongamia sericea, *Vent. Malm.* 28, *in obs.* ; *DC. Prodr.* ii. 416. Dalbergia angustifolia, *Hassk. Cat. Bogor.* 284, *Flora*, 1842, ii. *Beibl.* 53, *Pl. Jav. Rar.* 399. Millettia turgida, *Miq. Fl. Ned. Ind. Suppl.* 300. M. obtusa, *Blume, ex Miq. l. c.* i. 154. M. subcordata, *Blume ex Miq. l. c.* M. heterophylla, *Blume ex Miq. l. c.*

Frutex alte scandens vel vagans, ramis striatis breviter dense pubescentibus, tandem glabris, rarius lenticellatis. *Folia* 3–4-juga, 20–50 cm. longa, petiolo 6–10-plo longiora, rachi ut foliorum paginis inferioribus vestita ; stipulæ deciduæ, triangulares, 2–3 mm. longæ ; foliola superiora lateralia obovata vel oblonga, apice obtuse breviter acuminata, basi obtusa, rotundata vel rare subcordata, 6–24 cm. longa, coriacea, supra intense viridia, glabra, nitida, infra fulgentia, pube minuta squamosa argentea vel pallide brunnea vestita vel tandem fere glabra, venis marginem approximantibus 8–10-paribus supra paullo impressis subtus prominentibus ; petioluli 3–12 mm. longi ; stipellæ nullæ. *Paniculæ* racemiformes in axillis superioribus et in apice ramorum approximatæ, sic paniculam magnam generalem 30–50 cm. longam sæpissime formantes, terminalem vel nonnunquam lateralem, 20–30 cm. longæ, rachi ut ramulis, pedicellis, calycibus et vexilli paginis exterioribus breviter brunneo-sericea ; ramuli floriferi 7–8-flori, 2–5 mm. longi. *Flores* fasciculati, 0·8–1·2 cm. longi ; pedicelli 3–4 mm. longi ; bracteæ bracteolæque ovatæ, 1 mm. longæ, persistentes. *Calyx* late campanulatus, oblique truncatus, 2 mm. longus, 3 mm. latus, dentibus obscuris. *Vexilli* lamina orbicularis, interne rubida vel cærulea, basi obtusa, exauriculata, tenuiter callosa, ungue 2–3-plo longior ; alæ carinaque subfalcatæ, rubidæ vel purpureæ, striatæ. *Stamina* diadelpha, vexillare parce cohærens. *Discus* nullus. *Ovarium* lineare, pubescens, circiter 5-ovulatum. *Legumen* turgidum, ovale vel lineare, suturis incrassatis ante turgescentia fere in alam dorso productis, 6–14 cm. longum, 2–3 cm. latum, dense velutinum, tarde uno latere dehiscens; valvæ crasse coriaceæ, teretæ. *Semina* 1–4, oblonga, apicibus truncata, 3·3 cm. longa, 1·4 cm. crassa, testa fusca.

Flowers and fruits nearly all the year round.

Malay Penins.: Penang, *Curtis*, 844, 2967, *Phillips*; Perak, *Scortechini*, 1797 (Kwala Dipong), *Wray*, 2178 (Batu Togoh), 3164 (Simpang), *King's Collector*, 10479 (Ulu Bubong), 401 (Kota Bahru); Larut, *King's Collector*, 3179, 3960, 4042, 5804, 6844, 7019, 7299, 7366, 7493, *Wray*, 2364; Malacca, *Goodenough*, *Holmberg*, 888; Singapore, *Lobb*, 310.

Sumatra, *Junghuhn*, 72, *Herb. Blume* (Palembang), *Diepenhorst*, 695 (Priaman). *Teysmann*, *Forbes*, 3103 a, *Korthals*, 873.

Java, *Junghuhn*, 48, 223 (S. Hoehankola, Waldregion), *Hasskarl*, 3997 (Batu Dodol), *Zollinger*, *Horsfield*, 23.

New Guinea, *Herb. Blume*?

Var. malaccensis, *Prain in Journ. As. Soc. Beng.* lxvi. ii. (1897) 88. Legumen suturis haud incrassatis, utrinque dehiscens.

Malay Penins.: Malacca, *Maingay*, 1184, *Kew Dist.* 518, 518/2, and 1182, *Kew Dist.*, *Goodenough*, 1706, *Holmberg*, 834, *Hervey*, *Griffith*, 1764.

If these fruiting characters are substantiated when the Malacca plant is better known a distinct species will probably be separable. The pods in a young state bear a remarkable resemblance to those of *M. albiflora*.

Miquel has established several varieties and species upon forms which the abundant material now before me shows to be well within the variation of this one species, and no useful purpose would be served by any attempt to segregate it into them or any other groups besides the variety mentioned above. Certain tendencies in extreme parts of the geographical area may be, however, indicated. In the extreme north about Penang the leaflets are inclined to become smaller and the leaves to invade the panicle. In the south, Java and Sumatra, the flowers are rarely paniculate, in the north usually so.

The species was discovered in Java by the gardener accompanying the 'La Pérouse' expedition, and specimens were sent to Ventenat, who mentioned them in his 'Malmaison' under *Pongamia*. It was next received by Bentham from Sumatra. It thus happened that the species was described from forms with axillary inflorescences.

Blume gave names to forms (1) from Java with obtuse leaflets (*M. obtusa*, Blume ex Miquel, *l. c.*), (2) from New Guinea with subcordate leaflets (*M. subcordata*, Blume ex Miquel, *l. c.*), (3) from Sumatra with short pods (*M. heterophylla*, Blume ex Miquel, *l. c.*; *M. sericea* forma *brachycarpa*, Miq.). Miquel named a Sumatran plant, which does not seem to differ at all from the type, *M. turgida*.

32. M. PUERARIOIDES, *Prain in Journ. As. Soc. Beng.* lxvi. (1897) 358.—M. sericea, *Kurz in Journ. As. Soc. Beng.* xlv. II. (1873) 275; *For. Fl.* i. 353, non *Benth.*

Frutex alte scandens, caule 3–4 cm. diam., cortice pallido rugoso, ramis primo breviter ferrugineo-velutinis, mox glabris lenticellatis. *Folia* 2–3-juga, ad 60 cm. longa, petiolo 5-plo longiora, rachi ut ramis primo breviter velutinis et ut illis mox glabra; stipulæ triangulares, 2 mm. longæ, persistentes; foliola superiora lateralia lanceolata vel angustiora, apice valde gradatim caudato-acuminata, basi obtusa, 20–25 cm. longa, papyracea, supra primo in costa pubescentia, mox glabra, subtus dense griseo-sericea, fulgentia, venis marginem appropinquantibus 7-paribus sub marginem longe procurrentibus infra prominentibus; petioluli 5–6 mm. longi; stipellæ nullæ. *Paniculæ* racemiformes laterales, 25–35 cm. longæ, pendulæ, basi breviter nudæ; rachi primo dense puberula; nodi floriferi sæpe parvi, globosi, nonnunquam in ramulos 1 cm. longos producti. *Flores* fasciculati, 1·1–1·2 cm. longi; pedicelli 3 mm. longi; bracteæ bracteolæque 1–2 mm. longæ, lineares. *Calyx* campanulatus, 3 mm. longus, ut pedicelli bracteæ bracteolæque breviter sericeus, dentibus inconspicuis. *Petala* pallide rubida; vexilli lamina obovata, extus dense sericea, basi truncata, obscure callosa, ungue 2–3-plo longior; alæ paullo semisagittatæ; carinæ petala in unguem angustata, apice paullo sericea. *Stamina* monadelpha, vexillare basi solutum. *Discus* brevissimus. *Ovarium* sericeum, multiovulatum. *Legumen* turgidum, lineare, 17 cm. longum, 2·5 cm. latum, tandem subglabrum, tarde dehiscens?, valvis coriaceis. *Semina* ad 5, oviformia, testa fusca.

Flowers from April to June, fruits in February.

UPPER BURMA: *Shaik Mokim*, 79, *Anderson* (Poneshee, *type*); Kachin Hills, *Pottinger*.

LOWER BURMA: Pegu, *Kurz*, 1765 (Tongkyeghat, Nakawachoung, *type*); Tenasserim, *Gallatly*, 531 (Choungya at 4000 feet, *type*).

33. M. CAUDATA, *Baker in Hook. f. Fl. Brit. Ind.* ii. 109; *Kurz, For. Fl. Brit. Burm.* 352.—Pongamia caudata, *Grah. in Wall. Cat.* n. 5895. Otosema caudata, *Benth. in Miq. Pl. Jungh.* 249.

Frutex scandens, cortice pallido lenticellato. *Folia* 3–4-juga, 20–30 cm. longa, rachi glabra, petiolo 3–4-plo longiora; stipulæ nullæ; foliola superiora lateralia oblongo-lanceolata, longe caudata, basi obtusa, 9–13(–20) cm. longa, papyracea, supra glabra obscure reticulata, subtus glauca et primo adpresse sparse sericea, venis marginem appropinquantibus 9-paribus, infra prominulis; petioluli 4–5 mm. longi; stipellæ setaceæ, 1–2 mm. longæ, caducæ. *Racemi* sæpe laterales, nonnunquam in nodis ligni veteris fasciculati, 15–25 cm. longi, graciles, laxi, rachi apice puberula; nodi floriferi distantes, sessiles, 1–2 mm. longi, 1–2-flori. *Flores* 1–1·1 cm. longi; bracteæ minutæ, ovatæ, deciduæ. *Calyx* campanulatus, 3–4 mm. longus, membranaceus, tenuiter sericeus, dentibus obsoletis ; bracteolæ minutæ, caducæ. *Vexilli* lamina rotundata, basi subito in unguem 5-plo breviorem angustata, subcordata, obscure bicallosa, dorso dense sericea ; alæ angustæ, basi obtusæ ; carinæ petala conformia. *Stamina* monadelpha, vexillare basi solutum paullo dilatatum. *Discus* brevissimus, papillosus. *Ovarium* lineare, sericeum, multiovulatum. *Legumen* lineare, 10 cm. longum, 1·2 cm. latum, turgidum, adpresse sericeum, tandem glabrum, dehiscens, valvi suturis incrassatis. *Semina* 2–5, oblongo-ovoidea.

Flowers in April.

ASSAM : Khasia, *Hook. f. et Thoms.* (0–3000 feet), *Clarke*, 5514, *Wall. Cat.* 5895 (Silhet, *type*).

CULTIVATED : Calcutta Botanic Garden, No. 8 division (climber), "*Pongamia urophylla*," "*Tephrosia urophylla*."

34. M. DECIPIENS, *Prain in Journ. As. Soc. Beng.* lxvi. II. (1897) 90 and 360 (fructu excluso).

Arbor magna, ad 34 m. alta, ramulis fuscis rugosis, lenticellatis. *Folia* 4-juga, 12–16 cm. longa, glabra, petiolo 5-plo longiora ; stipulæ 0 ; foliola superiora lateralia oblongo-oblanceolata, acuminata, basi obtusa, 5–9 cm. longa, papyracea, subtus pallida sed non glauca (*Scortechini*), venis marginem appropinquantibus 7–9-paribus inconspicuis ; petioluli 4 mm. longi ; stipellæ nullæ. *Racemi* laxi, axillares, 10–15 cm. longi, rachi in parte superiore tenuiter ferruginea basi nuda ; nodi floriferi sessiles, 1–2-flori. *Flores* 7–8 mm. longi ; pedicelli 4–5 mm. longi, filiformes ; bracteæ nullæ ; bracteolæ minimæ, sæpe infra calycem, deciduæ. *Calyx* 2 mm. longus, 5 mm. latus, dentibus brevibus, pubescens. *Petala* rubida ; vexilli lamina oblata, basi truncata, auriculata, dorso brevissime sparse pubescens, ungue 4-plo longior ; alæ breviores, falcatæ ; carinæ petala basi truncata. *Stamina* monadelpha, vexillare basi et mox omnino solutum. *Discus* nullus. *Ovarium* pubescens, 4–5-ovulatum.

Flowers in February.

MALAY PENINS., *Scortechini*, 1749 (Kwala Dipong, *type*).

As the name implies, this species is liable to be confused with *Pongamia glabra*, Vent. Its rather smaller flowers, 4-ovuled ovaries, and lenticellate bark distinguish it. The fruiting specimens, which Prain referred to it, the pods of which he cited as distinguishing it from *Pongamia glabra*, belong rather, in the writer's opinion, to *M. Hemsleyana.*

35. M. DEHISCENS, *Prain, l. c.* 360 ; *Koorders, Excursionsfl. Java*, ii. 382.—Pongamia dehiscens, *Koorders et Valeton in Meded. 's Lands Plantent.* xiv. 96.

Arbor 10–12 m. alta, præter inflorescentiam glabra, ramulis rugosis lenticellatis. *Folia* 3–5-juga, 20–28 cm. longa, petiolo 4-plo longiora ; stipulæ nullæ; foliola superiora lateralia lanceolato-oblonga, acuminata, basi rotundata, 8–13 cm. longa, papyracea, venis marginem appropinquantibus 6–7-paribus; petioluli 5–6 mm. longi; stipellæ nullæ. *Racemi* axillares, 15–20 cm. longi, rachi, pedicellis calycibusque tenuiter laxe floccosis; nodi 1–2-flori. *Flores* 1·1 cm. longi; pedicelli filiformes, 1–1·5 cm. longi; bracteæ lineares, 7 mm. longæ, caducæ. *Calyx* patulus, 2–3 mm. longus. *Petala* cærulea; vexilli lamina rotundata, auriculata, dorso apice pubescens, ungue 3–4-plo longior; alæ utrinque obtusæ; carinæ petala ovata, in unguem longum subito contracta. *Stamina* monadelpha. *Discus* nullus. *Ovarium* pubescens, 5-ovulatum. *Legumen* lineari-oblongum, glabrum, suturis obtusis, 8–13 cm. longum, elastice dehiscens, valvis lignoso-coriaceis, 2–4-spermum. *Semina* suborbicularia, nitida, fusca; cotyledones orbiculares, basi oblique truncatæ; radicula teres, inflexa.

Flowers in September.

JAVA, *Koorders and Valeton*, 4105, 14191 (*types*), *Kuntze*, 5975 (Bromo-gebirge at 4500 feet).

36. M. OVALIFOLIA, *Kurz in Journ. As. Soc. Beng.* xlii. II. (1873) 68 (excl. syn.); *Baker in Hook. f. Fl. Brit. Ind.* ii. 107; *Kurz, For. Fl. Brit. Burm.* 356.

Arbor nonnumquam magna, præter pubescentiam sparsam deciduam in foliis novis et in inflorescentia omnino glabra, cortice pallido lævi. *Folia* (2–)3-juga, 15–20 cm. longa, petiolo 4-plo longiora; stipulæ nullæ; foliola superiora lateralia elliptica, apice obtusa, acuta vel leviter acuminata, basi rotundata, 3–7 cm. longa, papyracea, venis marginem approximantibus 6–8-paribus inconspicuis; petioluli 4–6 mm. longi; stipellæ nullæ. *Racemi* laxi, graciles, sæpius in ramulis aphyllis aggregati, 10–20 cm. longi; nodi floriferi parvi, 1–2-flori. *Flores* 7–8 mm. longi; pedicelli filiformes, 4–7 mm. longi; bracteæ nullæ; bracteolæ 1 mm. longæ, lineares, sæpe infra calycem insertæ. *Calyx* patulus, 1–2 mm. longus, præter marginem fere glaber, dentibus inconspicuis. *Petala* glabra; vexilli lamina rotundata, basi auriculata, in unguem 4–5-plo breviorem subito angustata; alæ utrinque basi obtusæ; carinæ petala ovata, subrostrata, basi truncata. *Stamina* monadelpha, vexillare basi solutum. *Discus* nullus. *Ovarium* lineare, pubescens, multiovulatum. *Legumen* lineare, ad 9 cm. longum, 1·5 cm. latum, glabrum, facile dehiscens, valvis lignosis, sæpius crebre lenticellosis, inter semina cohærentibus; legumina nova reticulata, suturis incrassatis.

Flowers in February and March, fruits in the following February to May.

LOWER BURMA: Pegu, *Kurz*, 2605, 2606 (*types*); Mergui, *Forest Dept.* ("Nantha"); Rangoon, *Meebold*, 15536, *Abdul Huk*, 51; Minbu, *Aubert and Gage*.

SIAM: Kanboerie, *Teysmann*, 6026.

Cultivated: Calcutta; Agri-Hort. Soc. Rangoon, *Proudlock*, 94; Agri-Hort. Soc. Lucknow.

The trivial name was conferred by Kurz on the supposition that *Pongamia ovalifolia*, Wight et Arn. (Prodr. 262), was the first name for the species. Wight and Arnott's plant appears, however, from the description to have different flowers, with two ovules in the centre of the ovary (like *P. glabra*) and with an ecallose standard.

37. M. glaucescens, *Kurz in Journ. As. Soc. Beng.* xlii. ii. (1873) 67; *Baker in Hook. f. Fl. Brit. Ind.* ii. 107; *Kurz, For. Fl. Brit. Burm.* 357; *Brandis, Ind. Trees*, 220.

Arbor magna, præter novella et inflorescentiam glabra, ramulis pallidis rugosis. *Folia* 3–4-juga, 16–30 cm. longa, petiolo 4-plo longiora; stipulæ oblongæ, 4 mm. longæ, caducæ; foliola lateralia superiora anguste oblongo-obovata, acuminata, basi cuneata, 8–10 cm. longa, papyracea, venis marginem approximantibus 8–10-paribus, infra prominulis; petioluli 4–5 mm. longi; stipellæ nullæ. *Racemi* axillares, laxi, 16–20 cm. longi, rachi gracili secus apicem ut pedicellis calycibusque tenuiter pubescente basi nuda; nodi floriferi sessiles, 1–2-flori. *Flores* 1 cm. longi, cyanei; pedicelli capillares, 4–5 mm. longi; bracteæ nullæ; bracteolæ minimæ, sæpe infra calycem insertæ. *Calyx* late campanulatus, 1·5–2 mm. longus, sparse breviter hirtus, dentibus parvis. *Petala* glabra; vexilli lamina rotundata, in basin auriculatam ungui æquilongam subito angustata; alæ utrinque obtusæ; carinæ petala ovata, rostrata, basi obtusa. *Stamina* monadelpha, vexillare basi solutum. *Discus* nullus. *Ovarium* tenuiter pubescens, 5-ovulatum. *Legumen* oblongum, 8–13 cm. longum, 3 cm. latum, primo intense glaucum, tandem glabrum, suturis in alas 3–4 mm. latas dilatatis, lenticellis ornatum, facile elastice dehiscens, valvis lignosis inter semina cohærentibus, 1–3-spermum. *Semina* compressa, fusca.

Lower Burma: Pegu, *Kurz*, 2613, 1777 (*types*), *Brandis*.

Shan States, *Collett*, 601 (Shan Hills terai).

Borneo, *Beccari*, 3070.

Cultivated: Madras, *Beddome*, 14.

Burmese name, *Taungka* (Brandis, *l. c.*).

38. M. Prainii, *Dunn*, sp. n.—M. glaucescens, *Prain in Journ. As. Soc. Beng.* lxvi. ii. (1897) 362 (p. p.), non *Kurz*.

Arbor magna, ramulis pallidis rugosis, fere omnino glabra. *Folia* 3–4-juga, 20–30 cm. longa, primo pilis paucis sparsis vestita, mox glabra, petiolo 6-plo longiora; stipulæ parvæ, ovatæ, 1–1·5 mm. longæ, deciduæ; foliola superiora lateralia ovato- vel lanceolato-oblonga, apice acuminata, basi obtusa, 8–13 cm. longa, chartacea tandem subcoriacea, venis marginem approximantibus

6-paribus tandem subtus prominentibus; petioluli 3–6 mm. longi; stipellæ nullæ. *Racemi* axillares, in ramulis brevibus foliosis aggregati, 8–11 cm. longi, rachi superius ut pedicellis marginibusque calycem laxe pubescente; nodi floriferi pauciflori, sessiles. *Flores* 9 mm. longi; pedicelli graciles, 3 mm. longi; bracteolæ paullo infra calycem affixæ bracteæque minutæ, lineares. *Calyx* patulus, 2 mm. longus, dentibus brevibus. *Vexilli* lamina rotundata, basi bicalloso-auriculata, dorso glabra; alæ carinæque petala oblongæ, basi obtusæ. *Stamina* monadelpha, vexillare basi solutum. *Ovarium* oblongum, adpresse sericeum, multiovulatum. *Legumen* lineari-oblongum, 8–12 cm. longum, 1·5–2 cm. latum, suturis incrassatis, anguste alatis, valvis 2 mm. crassis, alis supra eos 2 mm. stantibus.

Flowers in March and April, fruits ripe in the following March to May.

E. HIMALAYA: Sikkim, *Prain's Collector* (Kukna), 52 (Sevotie), *Cave*, 177 (Sivok), *Gamble*, 689 B (Chumbati at 2000 feet), 2238 A (Chongwong), 2240 C (Panchenai), *Ribu and Rhomoo*, 3614 (Assarbari plains).

CULTIVATED: Saharanpur, *Duthie*.

39. M. PTEROCARPA, *Dunn*, sp. n.—M. glaucescens, *Prain in Journ. As. Soc. Beng.* lxvi. II. (1897) 362 (p. p.), non *Kurz*.

Arbor magna, in fructu omnino glabra, cortice pallido lævi. *Folia* (3–)4-juga, 20 cm. longa, petiolo 5-plo longiora; stipulæ nullæ; foliola superiora lateralia oblonga, caudato-acuminata, basi obtusa, 9–10 cm. longa, papyracea, subtus pallida, venis marginem approximantibus 9-paribus infra prominentibus; petioluli 4 mm. longi; stipellæ nullæ. *Racemi* axillares, 8–13 cm. longi, pedunculati, nodis approximatis. *Legumen* lineare, ad 17 cm. longum, 3·5 cm. latum, glabrum, primo reticulatum, tandem læve, suturis anguste alatis, alis 4 mm. latis. *Semina* 2–3.

MALAY PENINS.: Perak, *Wray*, 168 (Kapayong, Kinta), *Scortechini*, *Fox*, 10788 (Ipoh).

Distinguished from *M. glaucescens* by the reticulation of its pods when young and of its leaves, and from *M. Prainii* by the narrow wings and broad valves of its pods.

40. M. TETRAPTERA, *Kurz in Journ. As. Soc. Beng.* xlii. II. (1873) 69; *Baker in Hook. f. Fl. Brit. Ind.* ii. 106; *Kurz, For. Fl. Brit. Burm.* 358.

Arbor 15–26 m. alta, ramulis primo velutinis, tandem glabris flavidis vel fuscis rugosis. *Folia* fusco-viridia, 2–3-juga, 15–30 cm. longa, petiolo 4-plo longiora, rachi ut eas racemorum velutina tandem glabrescente; stipulæ oblongæ, 3–4 mm. longæ, deciduæ; foliola lateralia superiora obovata, retusa, obtusa vel breviter acuminata, 8–13 cm. longa, subcoriacea, primo utrinque dense lanuginosa, tum supra glabra et ultimo utrinque præter venas majores infra tomentosas glabra, venis marginem appropinquantibus 7–8-paribus infra prominentibus; petioluli 4 mm. longi; stipellæ nullæ. *Racemi* versus apices ramulorum florigerorum congregati, nonnunquam infra folia ob foliationem apicis, 15–20 cm. longi; nodi floriferi sessiles, 2–5-flori, bractea lineari decidua suffulti. *Flores* congesti, 0·9–1·1 cm. longi; pedicelli 7 mm. longi; bracteæ bracteolæque minutæ. *Calyx* late campanulatus, 2–2·5 mm. longus, dentibus brevibus latis. *Petala* glabra; vexilli lamina oblata, ad basin auriculatam obtuse angustata, ungue 5-plo longior; alæ oblongæ, falcatæ; carinæ petala ovata, base truncata. *Stamina* monadelpha, vexillare basi solutum. *Discus* nullus. *Ovarium* lineare, pubescens, 4-ovulatum. *Legumen* lineare vel oblongum, ab initio tetrapterum, alis 1·0–1·2 cm. latis ex margine valvæ erectis, ad 15 cm. longum, 3 cm. latum, glabrum, elastice dehiscens, valvis lignosis inter semina cohærentibus. *Semina* nigra, oblato-sphæroidea, 1 cm. longa.

Flowers from March to June, fruits ripe from November to January.

UPPER BURMA, *Prazer*, *Badal Khan*, 142 (Maimyo), *Abdul Huk* (Sagaing and Kyoukse), *Shaik Mokim*, 636 (Minbu).

LOWER BURMA, *Wall. Cat.* 5976 (Yananghuen, *type*), 5977 (Thayatmiew, *type*), *Col. Eyre* (Pegu, *type*), 2597 (Pegu, *type*).

SHAN STATES: Monay, *Abdul Khalil.*

CULTIVATED: Calcutta, *Griffith*, *Kurz* (type); Saharanpur.

The Saharanpur tree bears racemes 4·5 cm. broad and flowers half as large again as those described above, but as it is in other respects similar to Kurz's types, it is probably merely a luxuriant form.

41. M. HEMSLEYANA, *Prain in Journ. As. Soc. Beng.* lxvi. II. (1897) 90 and 360.—M. decipiens, *Prain* (pro parte parva).

Arbor 7–17 m. alta, cortice griseo rugoso, ramulis primo pubescentibus, tandem glabris. *Folia* 3–4-juga, 15–20 cm. longa, petiolo 5-plo longiora, rachi pubescente glabrescente; stipulæ oblongæ, falcatæ, 7 mm. longæ, dorso pubescentes, per anthesin persistentes; foliola superiora lateralia oblongo-elliptica, acuminata, basi cuneata vel obtusa, 6–8 cm. longa, papyracea, primo utrinque dense floccoso-sericea, tum præter venas floccosas et tandem nonnunquam omnino glabra, venis marginem approximantibus 7–8-paribus tandem infra prominulis; petioluli 4 mm. longi; stipellæ nullæ. *Racemi* axillares vel in novellis aphyllis aggregati, 7–10 cm. longi, rachi laxe tomentosa; nodi floriferi sessiles, 1–4-flori. *Flores* 1·0–1·3 cm. longi; pedicelli capillares, 5 mm. longi; bracteæ lanceolatæ, deciduæ, 5 mm. longæ; bracteolæ non visæ. *Calyx* late campanulatus, 2·5 mm. longus, hirsutus, dentibus brevibus latis. *Petala* glabra, albo-rubida; vexilli lamina rotundata, in basin auriculatam subito contracta, ungue 5-plo longior; alæ oblongæ, basi truncatæ; carinæ petala ovata, apice paullo pubescentia, basi truncata. *Stamina* monadelpha, vexillare basi solutum. *Discus* nullus. *Ovarium* lineare, pubescens, multiovulatum. *Legumen* lineare, 15 cm. longum, 3·5 cm. latum, glabrum, elastice dehiscens, valvis tenuiter lignosis.

Flowers in January and February, fruits ripe in August.

MALAY PENINS.: Perak, *Wray*, 548 (Pluss River), 3608, 3308, 3310 (Polo Kamiri, *type*), *Ridley*, 14677, *King's Collector*, 10718; Pahang, *Ridley*, 2592, 2591 (Kwala Takau).

Nearest *M. pubinervis*, but distinguished when in flower by its large persistent stipules. There is difficulty in distinguishing some of the *Fragiliflorœ* when in fruit, and the fruiting specimens attached by Prain to *M. decipiens* appear to me to belong here, because the leaves of these specimens are pubescent on the midrib below as in the present species, while those of *M. decipiens* are quite glabrous even when young.

42. M. WRIGHTIANA, *Prain in Journ. As. Soc. Beng.* lxvi. II. (1897) 359.

Arbor 30 m. alta, ramulis brunneis rugosis striatis. *Folia* 2–3-juga, 15–25 cm. longa, petiolo 5-plo longiora, rachi ut petiolulis, ut pagina inferiore foliolorum et ut racemorum rachibus primo tenuiter lanuginosa, tandem fere glabra; stipulæ nullæ; foliola lateralia superiora ovata, obtuse acuminata, basi obtusa, 5–11 cm. longa, papyracea, venis marginem appropinquantibus 6-paribus infra prominulis; stipellæ nullæ. *Racemi* ad apices ramorum congesti, ante foliorum evolutionem florentes, 15–20 cm. longi; nodi floriferi sessiles, 2–4-flori. *Flores* fasciculati, 7 mm. longi; pedicelli filiformes, 4–5 cm. longi. *Calyx* patulus, 2 mm. longus, sparse pubescens, dentibus inconspicuis. *Petala* glabra; vexilli lamina oblata, in basin auriculatam subito contracta, ungue 4–5-plo longior; alæ oblongæ, subfalcatæ; carinæ petala ovata, subfalcata. *Stamina* monadelpha, vexillare basi solutum. *Discus* nullus. *Ovariam* lineare, pubescens, 7-ovulatum. *Legumen* immaturum lineare, ad 11 cm. longum, 1·5 cm. latum, glabrum, suturis incrassatis, valvis valde reticulatis.

UPPER BURMA, *Prazer* (type).

SHAN STATES, *Abdul Khalil* (Laikau and Saga, *types*, and Taungyi).

43. M. PUBINERVIS, *Kurz in Journ. As. Soc. Beng.* xlii. II. (1873) 68; *Baker in Hook. f. Fl. Brit. Ind.* ii. 106; *Kurz, For. Fl. Brit. Burm.* 357.

Arbor parva, cortice brunneo scabro. *Folia* 3–5-juga, 12–20 cm. longa, petiolo 4-plo longiora, rachi ut venis majoribus sub foliola, ut rachi pedicellis calycibusque inflorescentiæ lanugine flavida laxa tenuiter vestita; stipulæ caducæ; foliola superiora lateralia lanceolata, acuminata, basi cuneata, membranacea, præter pubescentiam citatam fere glabra, venis marginem approximantibus 6–7-paribus inconspicuis; petioluli 5 mm. longi; stipellæ nullæ. *Racemi* axillares, 12–15 cm. longi; nodi parvi pauciflori. *Flores* fasciculati, 1·0 cm. longi; pedicelli 4–5 mm. longæ; bracteæ membranaceæ, lanceolatæ, 4–5 mm. longæ ; bracteolæ nullæ. *Calyx* niger (*Gallatly*), late campanulatus, 2·5 mm. longus, tenuiter pubescens, dentibus inconspicuis. *Petala* alba et nigra (*Gallatly*) ; vexilli lamina rotundata, basi truncata, medio auriculata, ungue 4–5-plo longior, dorso pubescens ; alæ oblongæ, falcatæ ; carinæ petala lanceolata, falcata, apice paullo rostrata. *Stamina* monadelpha, vexillare basi solutum. *Discus* nullus. *Ovarium* lineare, pubescens, 6-ovulatum. *Legumen* lineare, 10–14 cm. longum, 2 cm. latum, glabrum, reticulatum, valvis coriaceis, suturis paullo incrassatis.

Flowers from April to August, fruits in September.

UPPER BURMA, *Brandis, Jackson* (Katha).

LOWER BURMA : Pegu, *Kurz*, 1778 (Tonkyeghat, *type*) ; Tenasserim, *Gallatly*, 562 ; Amherst, *Lace*, 4721.

SIAM : Doi Sootep at 1100 feet, *Kerr*, 1452.

44. M. LONGIPES, *Perkins, Fragmenta Fl. Philipp.* (1904) 80.

Arbor vel frutex, ramulis primo brunneo-pubescentibus tandem glabris pallidis. *Folia* 1–2-juga, 12–16 cm. longa ; foliola obovato-oblonga vel oblonga, longe obtuse acuminata, basi cuneata vel rotundata, 6–9 cm. longa, subcoriacea, utrinque glabra, venis marginem appropinquantibus 7–8-paribus infra prominulis. *Paniculæ* axillares, secus apices ramulorum, 15–20 cm. longæ, rachi ut ramulis pedicellisque ferrugineo-pubescente, ramulis laxis paucifloris. *Flores* 1 cm. longi, pedicelli 5–8 mm. longi, graciles. *Calyx* late campanulatus, paullo pubescens, 4 mm. longus, dentibus superioribus duo brevibus latis, infimo triangulari 1·5 mm. longo lateralibus paullo longiore. *Vexilli* lamina orbicularis, integra, dorso sparse pubescens. *Stamina* monadelpha, vexillare basi solutum. *Ovarium* pubescens. *Legumen* lineare, 6–9 cm. longum, 1·5 cm. latum, lignosum, læve, 3-spermum.

PHILIPPINE ISLANDS : Luzon, Isabela Province, *Warburg*, 12094, 12095, 12112 (Malum, *types*).

No specimens have been seen, the above description being taken from Perkins' and made uniform with the plan adopted in this paper.

45. M. CANARIIFOLIA, *Merrill in Philipp. Journ. Sci., Bot.* v. (1910) 71.

Arbor mediocris, saltem præter inflorescentia glabra, ramis brunneo-rubescentibus lenticellatis. *Folia* 3-juga, 18–20 cm. longa ; stipulæ nullæ ; foliola superiora lateralia oblongo-ovata, obtuse breviter acuminata, basi late rotundata, 6–9 cm. longa, coriacea, utrinque nitida, subtus pallidiora, venis 6–7-paribus infra prominulis ; petioluli 6–7 mm. longi ; stipellæ nullæ. *Racemi* axillares ; nodi floriferi sessiles, pauciflori. *Flores* ignoti. *Legumen* anguste oblongum, paullo falcatum, gradatim acuminatum, basi in stipitem angustatum, suturis paullo incrassatis, ad 13 cm. longum, 1·5–1·8 cm. latum, præter basin pubescentem glabrum ; pedicelli 1·8–2·0 cm. longi.

Fruits ripe in December.

PHILIPPINE ISLANDS: Luzon, Prov. of Zambales, Candelaria, *Bureau of Science*, 4711, 4727 (*types*).

The tree which is locally known as *Malapatpat*, as the collector Ramos states, was given its trivial name by Merrill in consequence of the resemblance of its leaves to those of *Canarium luzonicum*.

46. M. FOXWORTHYI, *Merrill in Philipp. Journ. Sci., Bot.* v. (1910) 72.

Arbor magna, præter flores glabra, ramis brunneo-rubescentibus lenticellatis. *Folia* 3-juga, 8–10 cm. longa, petiolo 4-plo longiora; stipulæ caducæ; foliola lateralia superiora oblongo-elliptica, ad apicem obtusum apiculatum angustata, basi rotundata et brevissime acuminata, 3·5–4·2 cm. longa, chartacea, subtus pallida, venis marginem appropinquantibus 5–6-paribus inconspicuis; petioluli 4–5 mm. longi; stipellæ nullæ. *Racemi* axillares, 5–6 cm. longi, in summis ramis congestis; nodi floriferi parvi, sessiles, pauciflori. *Flores* fasciculati, 1·2–1·5 cm. longi, præter vexillum apice paullo sericeum et ovarium paullo pubescens, glabri; pedicelli 7–8 mm. longi, filiformes, medio minute bibracteolati; bracteæ nullæ; bracteolæ 0·3 mm. longæ. *Calyx* tandem late campanulatus, 4 mm. longus, glaber, dentibus obscuris. *Petala* pallide purpurea; vexilli lamina rotundata, basi rotundata vel paullo sagittata, medio auriculata, ungue 5-plo longiora; alæ oblongæ, in unguem angustatæ; carinæ petala basi obtusa. *Stamina* monadelpha, vexillare basi solutum. *Discus* nullus. *Ovarium* lineare, fuscum, hirtis paucis pallidis vestitum, multiovulatum.

Flowers in March along river-banks at 250 m. altitude.

PHILIPPINE ISLANDS: Palawan, Mt. Victoria, *Bur. of Sci.* 740 (coll. by Foxworthy, *type*); Rizal, *Vidal*, 240, 1243 (San Mateo).

47. M. CAVITENSIS, *Merrill in Philipp. Journ. Sci., Bot.* v. (1910) 72.

Arbor mediocris, præter flores glabra, ramis griseis paullo lenticellatis. *Folia* bijuga, 16–20 cm. longa, petiolo 4-plo longiora; stipulæ 1–2 mm. longæ, oblongæ, caducæ; foliola superiora lateralia oblonga, apice acuminata, basi rotundata, 8–9 cm. longa, chartacea, utrinque nitida, venis marginem appropinquantibus 5-paribus ascendentibus inconspicuis; stipellæ nullæ. *Racemi* axillares, 12–20 cm. longæ, fere ad basin floriferi; nodi floriferi parvi, sessiles, pauciflori. *Flores* fasciculati, 2·4 cm. longi, præter vexillum dorso paullulo sericeum ovariumque pubescentia glabri; bracteæ nullæ; pedicelli 1–1·2 cm. longi, filiformes, medio minute bibracteolati. *Calyx* 4–6 mm. longus, campanulatus, dentibus obsoletis. *Petala* intense purpurea; vexilli lamina rotundata, basi medio auriculata, in unguem 3–4-plo breviorem subito angustata; alæ lineari-oblongæ, utrinque obtusæ; carinæ petala oblonga in unguem acute angustata. *Stamina* monadelpha, vexillare basi solutum. *Discus* nullus. *Ovarium* lineare, pubescens, 6-ovulatum.

Flowers in July. Along small streams in forest ravines at 250 m. altitude.

PHILIPPINE ISLANDS: Luzon, Cavite Province, *Merrill*, 4181 (Maragondong, *type*); Ilicos Norte Province, *Forestry Bureau*, 13815; Isl. of Paragua, *Vidal*, 2573 ("Calancan").

48. M. MERRILLII, *Perkins, Fragmenta Fl. Philipp.* (1904) 81.

Frutex præter flores glabra, ramis lævibus griseis. *Folia* 4–(5)-juga, 12–24 cm. longa, petiolo 4–5-plo longiora; stipulæ caducæ; foliola superiora lateralia oblonga, acuta vel obscure acuminata, basi rotundata, 4–6 cm. longa, papyracea, venis marginem appropinquantibus erecto-patentibus arcuatis 5–7-paribus utrinque inconspicuis; petioli graciles, 3 mm. longi; stipellæ nullæ. *Racemi* axillares, sæpius cum foliis paucis in novellis brevibus gesti, 5–14 cm. longi, breviter pedunculati; nodi floriferi parvi, sessiles, pauciflori. *Flores* fasciculati, 8–9 mm. longi, violaceo-rosei, præter calycem, vexilli apicem ovariumque paullulo pubescentes, glabri; pedicelli filiformes, 5–7 mm. longi, apice minute bibracteolati; bracteæ nullæ. *Calyx* late campanulatus, 2–2·5 mm. longus, fere omnino glaber, dentibus obsoletis. *Vexilli* lamina rotundata, basi obtusa, auriculata, in unguem brevem crassum abrupte transiens; alæ oblongæ, falcatæ, carinæ petala ovata, basi obtusa. *Stamina* monadelpha, vexillare basi solutum. *Discus* nullus. *Ovarium* sparse pubescens, lineare, 5-ovulatum. *Legumen* lineare, ad 10 cm. longum, 1·5 cm. latum, complanatum, dehiscens, valvis tenuiter lignosis, apice acuminatum, basi in stipitem brevem angustatum.

Flowers in April and ripens fruit in the following February to April.

PHILIPPINE ISLANDS: Luzon, Benguet, *Elmer*, 6166 (Sablan); Pampanga, *Merrill*, 1387 and 3831 (Arayat, *type*), *Loher*, 2415 (Arayat); Rizal, *Merrill*, 1633, 1625 (*type*), 2801, *Vidal*, 2572, *Bur. of Sci.* 2178, *Loher*, 2413, 2414 (Antipolo), 2416 (San Mateo); Manila, *Warburg*, 12891 and 12578 (Montalban, *types*); Mindoro, *Merrill*, 9821.

Apparently a common plant in Luzon, being recorded by Merrill, in his "Enumeration of Philippine Leguminosæ," from the Provinces of Isabela, Cagayan, Union, Pampanga, Bulacan, and Rizal. One locality in Mindoro is also on record. The native names in Rizal are *Baloc* and *Baloc-baloc*, in Pampanga *Bani* and *Malabay*.

49. M. CAPILLIPES, *Dunn in Philipp. Journ. Sci., Bot.* vi. (1912) 316.

Frutex 5 m. altus, præter ovarium omnino glaber, cortice griseo. *Folia* bijuga, 15 ad 20 cm. longa, exstipulata; foliola superiora lateralia lanceolata, apice gradatim acuminata, basi acuta, 6 ad 10 cm. longa, chartacea, nervis utrinque 5 ad 7 subtus paullo prominulis; petioluli 4 ad 5 mm. longi; stipellæ nullæ. *Racemi* axillares, 10 ad 12 cm. longi, laxiflori. *Flores* 1- vel 2-ni, 1 cm. longi; pedicelli capillacei, 4 ad 6 mm. longi, sub flore minute bibracteolati. *Calyx* patulus, 2 mm. longus, truncatus. *Petala* rubida; vexilli lamina rotundo-ovata, basi fortiter bicallosa, truncata, in unguem subito angustata; alæ carinaque oblongæ, basi in unguem angustatæ. *Stamina* monadelpha, vexillare basi solutum. *Ovarium* sessile, pubescens.

PHILIPPINE ISLANDS: Luzon, Province of Isabela, Cabagan River, *Forestry Bureau*, 18549 (collected by Alvarez).

50. M. AHERNII, *Merrill et Rolfe in Philipp. Journ. Sci., Bot.* iii. (1908 103; *Merrill, l. c.* v. (1910) 71.

Arbor parva, saltem præter inflorescentiam non visam glabra, ramis pallide brunneis lenticellatis. *Folia* (3–)4-juga, 20–24 cm. longa, petiolo 5-plo longiora; stipulæ non visæ; foliola superiora lateralia ovato-oblonga, apice breviter acuminata, basi obtusa brevissime acuminata, 8–9 cm. longa, subcoriacea, venis 6–8-paribus erecto-patentibus infra prominentibus; petioluli 5 mm.; stipellæ nullæ. *Racemi* in axillis foliorum summorum, 15–20 cm. longi, parte inferiore nudi, 8–12 cm. longi; nodi floriferi sessiles, pauciflori. *Ovarium* 6-ovulatum. *Legumen* lineare, apice basique obtusum, 18–20 cm. longum, 2–2·5 cm. latum, facile dehiscens, valvis lignosis, suturis incrassatis, inter semina liberis. *Semina* 4–6, compressa.

Fruits from June to Sept.

PHILIPPINE ISLANDS: Rizal, *Forestry Bureau*, 3373 (Bosoboso, *type*), *Bureau of Sci.* 12436, 5221 (San Mateo); Ilocos, *Forestry Bur.* 5655.

51. M. STIPULATA, *Dunn in Philipp. Journ. Sci., Bot.* vi. (1912) 316.

Arbor 20 m. alta, præter inflorescentiam omnino glabra, cortice rugoso griseo, ligno flavo. *Folia* bijuga, 20 cm. longa; stipulæ persistentes, oblongæ, falcatæ, reflexæ, 4 mm. longæ; foliola late ovata, gradatim breviter caudata, basi obtusa vel truncata, ad 10 cm. longa, papyracea, subtus glaucescentia, nervis utrinque 6, valde arcuatis; petioli 5 mm. longi; stipellæ nullæ. *Racemi* axillares, 7 cm. longi, pedunculis 1- ad 2-plo longiores, rachi ut pedicellis, calycibus petalisque laxe sparseque pubescenti. *Flores* 10 ad 12 mm. longi, pedicellis filiformibus 6 ad 8 mm. longis. *Calyx* breviter campanulatus, fere truncatus, tandem patulus; bracteolæ minutæ, hirsutæ. *Petala* alba; vexilli lamina ovata, ecallosa, basi plicata, in unguem brevem angustata; alæ semisagittatæ; carina cuneato-oblonga. *Stamina* monadelpha. *Ovarium* lineare, paullo ad apicem tenuiter pubescens, basi disci papillis cinctum.

PHILIPPINE ISLANDS: Luzon, Province of Bulacan, Angat, *For. Bur.* 11140 (collected by Aguilar).

52. M. LITORALIS, *Dunn in Philipp. Journ. Sci., Bot.* vi. (1912) 316.

Arbor parva (?), ramis fuscis lenticellatis. *Folia* 5- vel 6-juga, 14 ad 17 cm. longa, glabra, petiolo 5-plo longiora; stipulæ ovatæ, persistentes, 2 ad 3 mm. longæ ; foliola superiora lateralia ovato-oblonga, obtuse acuminata, basi rotundata, 4 ad 5 cm. longa, papyracea, utrinque paullo reticulata, venis 5- vel 6-paribus; petioluli 2 ad 3 mm. longi; stipellæ nullæ. *Racemi* axillares et, supra folia, stipulis tantum suffulti, paniculam formantes, ad 25 cm. longi, pedunculati, rachibus præcipue apice dense adpresse pubescentibus ; nodi floriferi brevissimi. *Flores* fasciculati, 1 cm. longi ; pedicelli 8 ad 10 mm. longi, tenuiter albo-puberuli ; bracteæ minutæ ; bracteolæ caducæ. *Calyx* late patulus, 2 mm. longus, 3 mm. latus, infra puberulus, obscure dentatus. *Petala* alba, minute et sparse puberula ; vexilli lamina reflexa, ovata, basi conduplicata nec callosa, in unguem angustata, ungue bis longior ; alæ angustæ, semisagittatæ ; carinæ petala basi truncata. *Stamina* monadelpha. *Discus* unilateralis brevis. *Ovarium* lineare, tenuiter puberulum.

PHILIPPINE ISLANDS : Mindanao, District of Davao, Santa Cruz, *De Vore & Hoover*, 250.

53. M. AURICULATA, *Baker ex Brandis, For. Fl.* (1874) 138 ; *Baker in Hook. f. Fl. Brit. Ind.* ii. 108 (1876) ; *Brandis, Ind. Trees,* 220, t. 95 ; *Gamble, Manual Ind. Timb.* 233 (1902).—M. macrophylla, *Kurz. in Journ. As. Soc. Beng.* xlv. II. (1876) 276, non *Hook. f.* Robinia macrophylla, *Roxb. Hort. Beng.* (1814) 56 (nomen) ; *Fl. Ind.* iii. (1832) 329. Pongamia macrophylla, *Grah. in Wall. Cat.* n. 5892 (1828). Otosema macrophylla, *Benth. Pl. Jungh.* 249. M. extensa, *Benth. ex Baker in Hook. f. Fl. Brit. Ind.* ii. 109 ; *Kurz, For. Fl. Brit. Burma,* 352 ; *Prain in Journ. As. Soc. Beng.* lxvi. II (1897) 363. Pongamia extensa, *Grah. in Wall. Cat.* n. 5900. Otosema extensa, *Benth. in Miq. Pl. Jungh.* 249.

Frutex alte scandens, ramulis primo velutinis tandem glabris, cortice fusco rugoso. *Folia* 3–4-juga, 20–50 cm. longa, petiolo 3–4-plo longiora, rachi ut eis panicularum pedicellisque breviter tomentosa glabrescente ; stipulæ persistentes, reflexæ, oblongæ, 7 mm. longæ ; foliola superiora lateralia ovato-oblonga, apice breviter acuminata, basi rotundata, 8–16 cm. longa, chartacea, utrinque primo adpresse sericea, tandem præter venas infra tomentosas glabra, venis marginem appropinquantibus 8–10-paribus infra prominentibus ; petioluli 4 mm. longi ; stipellæ setaceæ, 1–2 mm. longæ, deciduæ. *Racemi* sæpe aggregati in basi ramulorum lateralium tandem elongatorum apice foliatorum, 10–30 cm. longi ; nodi floriferi sessiles vel breviter stipitati, stipitibus ad 5 mm. longis, pauciflori. *Flores* fasciculati, ·8–1·2 cm. longi ; pedicelli 3 mm. longi ; bracteæ nodorum florumque et bracteolæ lineares, deciduæ. *Calyx* campanulatus, 3 mm. longus, dense pubescens, dentibus brevibus latis. *Petala* flavido-viridia ; vexilli lamina orbicularis, media basi auriculata, dorso dense sericea, ungue 5-plo longior ; alæ lanceolatæ, falcatæ ; carinæ petala ovata, basi truncata. *Stamina* monadelpha, vexillare basi solutum. *Discus* cupularis, obliquus, 1 mm. longus.

Ovarium lineare, sericeum, multiovulatum. *Legumen* lineare, ad 15 cm. longum, 3 cm. latum, primo velutinum, tandem fere glabrum, elastice dehiscens, valvis coriaceis. *Semina* ad 8, fusca, lenticularia.

Flowers March to June, fruits from September to March.

C. INDIA: Oude, *Wall. Cat.* 909 C, *Jerdon, Herb. Rep. Ec. Prod.* 20204 (Heshangabad), 18078 (Malwa Tal), *Beddome*, 37.

W. HIMALAYA, *Royle*, *Thomson*; Kumaon, *Thomson*, 852, *Strachey and Winterbottom*; Siwaliks, *Meebold*; Gharwal, *King* (Bhabur); Dehra Dun, *King*, *Webb* (Kalsi); Bahraich, *Rep. Ec. Prod.* 23348; Nepal, *Rep. Ec. Prod.* 29992 (Churia), 29462; Mussourie, *King*.

E. HIMALAYA: Sikkim, *Hooker*, *Clarke*, 9040 C and 26551 E (Darjeeling), 11685 C, 11687 (Siligoree), 13829 H (Punkabari); Bhutan, *Griffith*, 1787.

BENGAL: Chota Nagpur, *Wood*, *Prain*, *Gamble*, 8843; Parasnath, *Clarke*, 21295 B, 33758 B; Rajmahal Hills, *Kurz*; Orissa, *Lace*; Singbhum, *Betts*; Manbhum, *Campbell*.

ASSAM, *Forest Herb.* 700 (Soalpara Dist.), *King's Collector*, *Fisher*.

CULTIVATED: Calcutta Botanic Garden, *Wall. Cat.* 5892, 5892 A (*types*).

IC. INED. *Roxb.* n. 2329 (Libr. Kew).

Forma EXTENSA.—M. extensa, *Benth.*, syn. as above.—M. auriculata *var.* extensa, *Prain in Journ. As. Soc. Beng.* lxvi. II. (1897) 363.

Racemi breviores.

UPPER BURMA: Maimyo, *Badal Khan*, 10, *Lace*, 3282, 3135; Chin Hills, *Dun*; Upper Chindwin, *Meebold*, 7847; *Prazer*, 23, *Abdul Huk* (Kyoukmyoung).

LOWER BURMA: Pegu, *Kurz*, 1774, 2534, *McClelland*; Moulmein, *Wall. Cat.* 5900 (*type*), *Falconer*, 572; Tenasserim, *Meebold*, 15560, *Gallatly*, 29, 573, 903; Henzada, *Shaik Mokim*, 1721, 1471.

SHAN STATES, *MacGregor*, 808.

SIAM, *Kerr*, 595, 1724 (Doi Sootep).

As Prain points out (*loc. cit.*), there is really no difference between the forms which were long known as *M. macrophylla* and *M. extensa*. The extreme long-racemed form was first known from Central India, the short-racemed one from Lower Burma, but the accumulation of material from intermediate stations and in transitional states has gradually broken down the geographical and morphological partition until, on our present knowledge, we should not be justified in regarding them as more than geographical forms.

Brandis (*l. c.*) gives the following native names: Hindi *Gauj*, Oudh *Maudh*, Gond *Gurar*, Burmese *Wunu*. Gamble (*l. c.*) describes the bark and wood and gives numerous native names in addition to the above. In No. I. Museum in the Royal Botanic Gardens, Kew, are specimens of the stem and a fibre obtained therefrom.

54. M. FRUTICOSA, *Benth. ex Baker in Hook. f. Fl. Brit. Ind.* ii. 109 (*excl. syn.* Amerimnum? fasciculatum, *Ham. MS. and distr. Pegu*) ; *Kurz, For. Fl. Brit. Burm.* 352.—Robinia fruticosa, *Roxb. Fl. Ind.* iii. 328. Pongamia fruticosa, *Grah. in Wall. Cat.* n. 909. Otosema fruticosa, *Benth. in Miq. Pl. Jungh.* 249. Tephrosia fruticosa, *DC. Prodr.* ii. 249.

Frutex tandem scandens (*Roxb.*), cortice primo ferrugineo tandem glabro scabro. *Folia* 3–5-juga, 15–30 cm. longa, petiolo 3–4-plo longiora, rachi ut petiolulis venisque majoribus foliolorum ferrugineo-villosa supra canaliculata : stipulæ oblongæ, pubescentes, persistentes ; foliola superiora lateralia lineari-oblonga, obtusa vel breviter obtuse acuminata, 9–10 cm. longa, chartacea, præter venas glabra, venis marginem approximantibus 10-paribus, parallelis ; petioluli 3 mm. longi ; stipellæ setaceæ, 1 mm. longæ. *Racemi* singuli vel fasciculati axillares vel in paniculam terminalem collecti, 9–14 cm. longi, rachi dense pubescente ; nodi biflori, globulares, bracteis persistentibus brevibus linearibus suffulti. *Flores* subsessiles, 1 cm. longi ; pedicelli ·5 mm. longi ; bracteæ nullæ ; bracteolæ ovatæ, 1–2 mm. longæ, tandem deciduæ. *Calyx* late campanulatus, breviter sericeus, dentibus brevibus latis. *Vexilli* lamina rotundata, basi auriculata, dorso sericea, in unguem 4–5-plo breviorem subito contracta; alæ basi obtusæ, paullo saccatæ; carinæ petala concava, in unguem angustata. *Stamina* monadelpha, vexillare basi solutum. *Discus* nullus. *Ovarium* lineare, sericeum, multiovulatum.

Flowers in June.

BENGAL, *Griffith, Kew Dist.* 1813, *Wall. Cat.* 909 (*type*).

CULTIVATED : Calcutta Botanic Gardens, *Griffith, Kew Dist.* 1771 (*type*), *Wall. Cat.* 909, 909 B (*types*).

IC. INED. *Roxb.* n. 1891 (Libr. Kew).

The types of the species may confidently be sought among the specimens collected in early days in the Calcutta Gardens. Roxburgh described it from a tree growing there which had been raised from seed received from Chupra (Bengal) in 1803. He noted that the branches begin to climb when 4–5 years old. The chief difference between this species and *M. auriculata* forma *extensa* lies in the process of inflorescence, the former producing a terminal panicle or racemes, one or more together in the axils of leaves, while the latter bears large numbers of racemes from the base of lateral shoots which afterwards lengthen and produce leaves.

55. M. CÆRULEA, *Baker in Hook. f. Fl. Brit. Ind.* ii. 107 ; *Kurz, For. Fl. Brit. Burm.* 354.—Pongamia cærulea, *Grah. Wall. Cat.* n. 5894. Robinia? cærulea, *Wall. ex Baker l. c.*

Frutex scandens, cortice lævi striato. *Folia* 3–(4-)juga, 30–50 cm. longa, petiolo 3–4-plo longiora, rachi ut foliolis inferius breviter tenuiter adpresse sericea ; stipulæ lineares, 4–6 mm. longæ, persistentes ; foliola superiora lateralia oblongo-oblanceolata, apice breviter acuminata, caudata, 16–18 cm.

longa, chartacea, supra nitida, infra reticulata, venis 8–10-paribus supra impressis infra prominulis; petioluli 5–8 mm. longi; stipellæ setaceæ, 2 mm. longæ. *Paniculæ* racemiformes axillares et paniculam generalem 40 cm. longam formantes, rachi pubescente; nodi floriferi ad 4 mm. longi, apice pauciflori. *Flores* fasciculati, ·8 cm. longi; pedicelli 3 mm. longi; bracteæ et bracteolæ lanceolatæ, 2 mm. longæ, deciduæ. *Calyx* patulus, 2 mm. longus, sparse sericeus, dentibus brevibus latis. *Petala* purpurea; vexilli lamina rotundata, basi obtusa, medio bicallosa, dorso dense sericea, ungue 4–5-plo breviore, apice pubescente; alæ rotundatæ, falcatæ, medio hirtæ; carinæ petala ovata, rostrata, basi obtusa. *Stamina* monadelpha, vexillare basi solutum. *Discus* brevis, papillosus. *Ovarium* oblongum, sericeum, 3-ovulatum.

LOWER BURMA: "Hill at Phanoe, 10.5.1827. *Robinia? cærulea*, Wall. Cat. 5894" (*type*).

SIAM: Hills between Me Ta and Me Awn, May 10, 1912, at 2000 ft., *Kerr*, 2579.

As far as can be discovered, the species had, before 1912, only once been gathered, and that at Phanoe in May 1827. The specimen in Wallich's own herbarium in the rooms of the Linnean Society and the one in Kew Herbarium, which may be part of it, are small and imperfect.

56. M. PACHYLOBA, *Drake in Journ. de Bot.* v. (1891) 187.

Frutex alte scandens, cortice rugoso fusco. *Folia* sæpissime 4-juga, 20–30 cm. longa, petiolo 3–4-plo longiora, rachi ut caulibus ramisque inflorescentiæ primo sericea, glabrescente; stipulæ late triangulares, 2–3 mm. longæ, persistentes; foliola lateralia superiora obovato-oblonga vel anguste elliptica, basi rotundata vel obtusa, apice obtusa vel brevissime acuminata, 7–10 cm. longa, chartacea, supra glabra, infra adpresse sericea, venis regularibus numerosis approximatis omnibus in venam marginalem procurrentibus 13–14-paribus erecto-patentibus supra impressis subtus prominentibus; petioluli 4–6 mm. longi; stipellæ 3 mm. longæ, setaceæ. *Panicula* terminalis, nonnunquam basi foliosa, 20–30 cm. longa; rami longi, ascendentes, anguste paniculati; ramuli floriferi 4–5 mm. longi, sericei, apice umbellam gerentes. *Flores* 1·4–1·5 cm. longi; pedicelli 3 mm. longi; bracteæ minutæ triangulares. *Calyx* campanulatus, 2·5 mm. longus, 4 mm. latus, velutinus; bracteolæ lanceolatæ, 3-plo tubo breviores. *Vexilli* lamina rotundata, basi bicallosa, externe griseo-sericea, intus glabra, alba, lineis violaceis striata, ungue 4–5-plo breviore; alæ oblongæ, basi truncatæ, violaceæ; carinæ petala concoloria et conformia. *Stamina* diadelpha. *Discus* nullus. *Ovarium* lineari-lanceolatum, sericeum, 4-ovulatum.

COCHIN CHINA: Tonkin, *Balansa*, 2306 (Tu-Phap, *type*).

CHINA: Hainan, *Ford's Collector*, 368 (Nar-tai), *Henry*, 8489, *Hongkong Herb.* 6638 (collected by Katsumata on Ng Chi Shan).

56 *a*. M. MULTIFLORA, *Coll. et Hemsl. in Journ. Linn. Soc., Bot.* xxviii. (1890) 41 ; *Prain in Journ. As. Soc. Beng.* lxvi. II. (1897) 359.

Arbor 10–13 m. alta, novellis rufo-tomentellis, cortice pallido lævi. *Folia* 5–6-juga, 12–16 cm. longa, petiolo 3-plo longiora, rachi ut paginis inferioribus foliolorum, ut pedunculis et pedicellis, breviter dense pubescentibus tandem fere glabris; stipulæ lineares, persistentes; foliola superiora, lateralia elliptica, apice obtusa vel breviter obtuse acuminata, basi rotundata, 2·5–3 cm. longa, subcoriacea, utrinque reticulata, venis marginem appropinquantibus 6–8-paribus infra prominulis ; petioluli 2–2·5 mm. longi ; stipellæ setaceæ, 1 mm. longæ. *Paniculæ* racemiformes, versus apicem novellorum aggregatæ, ante foliorum evolutionem florentes, 15–20 cm. longæ ; nodi floriferi breves, multiflori. *Flores* 1·5 cm. longi ; pedicelli 3–4 mm. longi ; bracteæ bracteolæque minutæ. *Calyx* campanulatus, 6–7 mm. longus, dentibus tubo 3–4-plo brevioribus, tenuiter sericeus. *Vexilli* lamina ovata, basi in unguem 2–3-plo breviorem abrupte angustata, auriculis 2 ovatis erectis, dorso sericea ; alæ anguste oblongæ, basi utrinque obtusæ ; carinæ petala oblonga, basi truncata. *Stamina* diadelpha. *Discus* papillis paucis inconspicuis repræsentatus. *Ovarium* lineare, sericeum, multiovulatum. *Legumen* fere maturum lineare, 9 cm. longum, 2 cm. latum, valvis rugosis reticulatis, suturis incrassatis.

Flowers in April, fruits in July.

UPPER BURMA, *Collett*, 516, 553 (Possbio, *types*), *Abdul Huk* (Kyoukmyoung).

56 *b*. M. CANA, *Benth. ex Baker in Hook. f. Fl. Brit. Ind.* ii. 105 ; *Kurz, For. Fl. Brit. Burm.* 355.—Pongamia cana, *Grah. in Wall. Cat.* n. 5903.

Arbor? ramulis foliisque primo griseo-tomentosis tandem glabris. *Folia* 3–4-juga, 30 cm. longa, petiolo 4-plo longiora ; stipulæ parvæ rigidæ persistentes ; foliola lateralia superiora obovata, obtusa vel obtusissime acuminata, sæpe retusa, 8–9 cm. longa, chartacea, utrinque reticula, venis marginem appropinquantibus 7-paribus utrinque prominentibus ; petioluli 4 mm. longi ; stipellæ aciculares, 1 mm. longæ. *Paniculæ* racemiformes axillares, 15 cm. longæ ; nodi floriferi breves. *Calyx* 4 mm. longus, velutinus, dentibus parvis. *Legumen* oblongum, ad semina incrassatum, 9 cm. longum, 2·5 cm. latum, ad maturitatem griseo-tomentosum, dehiscens.

Fruits ripe in November.

UPPER BURMA, *Wall. Cat.* 5903 (Irrawaddi, *type*), *Shaik Mokim*, 469, 1083 (Minbu).

The leaves are thickly tomentose in January, subglabrous in November.

57. M. PENDULA, *Benth. ex Baker in Hook. f. Fl. Brit. Ind.* ii. 105 ; *Gamble, Manual Ind. Timb.* (1902) 233 ; *Coll. et Hemsl. in Journ. Linn. Soc., Bot.* xxviii. (1890) 40 ; *Brandis, Ind. Trees*, 220.—Pongamia pendula, *Grah.*

in Wall. Cat. 5902. M. leucantha, *Kurz in Journ. As. Soc. Beng.* xlii. II. (1873) 68, xlv. II. (1876) 275; *Fl. Brit. Burm.* 356.

Arbor magna, cortice albido lævi. *Folia* (2–)3-juga, 20–25 cm. longa, petiolo 3–4-plo longiora, rachi ut pagina inferiore foliolorum ad anthesin dense adpresse hirta, in fructu glabra; stipulæ ovatæ, paullo persistentes, ovatæ, 2–3 mm. longæ; foliola superiora lateralia ovato-lanceolata, acute acuminata, basi obtusa, 8–14 cm. longa, chartacea, supra nitida, venis marginem approximantibus 7–9-paribus infra prominulis; petioluli 4–5 mm. longi; stipellæ setaceæ, 1–3 mm. longæ. *Paniculæ* racemiformes terminales, 10–12 cm. longæ, rachi pedicellis calycibusque dense adpresse hirtis; nodi multiflori, 2–3 mm. longi. *Flores* congesti, 1–1·1 cm. longi; pedicelli 4–5 mm. longi; bracteæ bracteolæque minutæ, deciduæ. *Calyx* campanulatus, 5 mm. longus, pubescens, dentibus triangularibus tubo bis brevioribus. *Petala* flavida, glabra; vexilli lamina rotundata, basi cordata, bicalloso-auriculata; alæ oblongæ, falcatæ, saccatæ; carinæ petala ovata, falcata. *Stamina* paullo perigyna, monadelpha, vexillare basi solutum. *Discus* nullus. *Ovarium* lineare, sericeum, multiovulatum. *Legumen* oblongum, sæpius apice basique obtusum, glabrum, elastice dehiscens, valvis lignosis inter semina cohærentibus lenticellatis. *Semina* oblonga, 1·5 cm. longa, 6 mm. lata.

Flowers in March, fruits from June to February.

UPPER BURMA: Lower Chindwin, *Lace*, 4167, *Prazer*, 64; Ruby Mines, *Abdul Huk*, 173; Fort Stedman, *Abdul Huk*; Yamethin, *Lace*, 4530.

LOWER BURMA: Pegu, *Kurz*, 2600, 1769, *Brandis*, *Henderson*; Prome, *Wall. Cat.* 5902 (*type*), *McClelland*.

SHAN STATES, *Collett*, 436, *Abdul Huk*.

SIAM: Mt. Satoepat, *Teysmann*, 5948.

Var. GLABRA, *Dunn*, var. nov. Folia etiam per anthesin glabra.

SHAN STATES, *Collett*, 482.

Kurz himself first recognised the identity of his *M. leucantha* with *Pongamia pendula*, Grah., which he cites as a synonym in Journ. As. Soc. Beng. xlii. II. 275.

Brandis states (Ind. Trees, 220) that the Burmese name is *Thinwin* and that the heart-wood is dark purple in colour.

Gamble (Man. Ind. Timb. 233) describes the wood as having a beautiful grain and dark colour.

c144 58. M. LATIFOLIA, *Dunn*, sp. n.

Arbor? præter flores omnino glabra, cortice pallido rugoso; gemmæ complanatæ, striatæ. *Folia* bijuga, 20–30 cm. longa, petiolo 5-plo longiora; stipulæ persistentes, lineari-oblongæ, 4–5 mm. longæ; foliola superiora lateralia ovata, utrinque obtusa, 10–13 cm. longa, chartacea, venis marginem approximantibus 10–12-paribus parallelis infra prominulis; petioluli 5 mm.

longi; stipellæ persistentes, setaceæ, 1–1·5 mm. longæ. *Panicula* racemiformis terminalis, nutans, 15–20 cm. longa; ramuli floriferi multiflori, 5–6 mm. longi. *Flores* aggregati, 1·3–1·4 cm. longi; pedicelli 8 mm. longi, medio bibracteolati. *Calyx* campanulatus, 6 mm. longus, breviter sericeus, dentibus 4, tubo æquilongis, superiore apice bifido. *Petala* glabra, alba, fragilia; vexilli lamina rotundata, basi leviter transverse callosa, utrinque minute inflexa, in unguem 3-plo breviorem subito angustata; alæ oblongo-ovatæ, falcatæ; carinæ petala ovata, basi subfalcata. *Stamina* monadelpha, vexillare basi solutum, perigyna. *Discus* calyci adnatus. *Ovarium* lineare, sericeum, medio 4-ovulatum. *Legumen* fere maturum obovato-oblongum, 11 cm. longum, 3–3·5 cm. latum, glabrescens, suturis incrassatis, valvis robustis rugulosis.

Flowers March.

SIAM: Doi Sootep, *Kerr*, 1733 (at 1200 feet).

60179 59. M. SETIGERA, *Dunn*, sp. n.

Arbor 4–10 m. alta, cortice fusco lævi; gemmæ setis fasciculatis suffultæ et apices ramulorum stipulis acicularibus persistentibus armati. *Folia* 5-juga, 25–35 cm. longa, petiolo 5-plo longiora; stipulæ aciculares, 4–5 mm. longæ, persistentes; foliola superiora lateralia, oblanceolata, acuminata, basi cuneata, 9–10 cm. longa, membranacea, glabra, venis principibus 7-paribus inconspicuis; stipellæ aciculares, 1–1·5 mm. longæ. *Paniculæ* racemiformes in basi ramulorum infra folia enatæ, 15–25 cm. longæ, rachi sparse pubescente; nodi floriferi in stipitibus 4 mm. longis vel rarius sessiles, 3–4-flori. *Flores* fasciculati, 1·7–1·9 cm. longi; pedicelli 7–9 mm. longi, filiformes; bracteæ nullæ; bracteolæ lineares, 1–2 mm. longæ, paullo infra florem insertæ. *Calyx* patulus, 5 mm. longus, pubescens, dentibus brevibus inconspicuis. *Petala* glabra rosea; vexilli lamina ovata, basi subcordata, valde auriculata, ungue 4-plo longiora; alæ oblongæ, subfalcatæ; carinæ petala basi obtusa. *Stamina* monadelpha, vexillare basi solutum. *Discus* brevissimus. *Ovarium* pubescens, lineare, multiovulatum. *Legumen* lineare, ad 20 cm. longum, 3 cm. latum, glabrum, paullo rugulosum, suturis paullo incrassatis.

Flowers in June, fruits ripe in January.

COCHIN CHINA: Tonkin, *Balansa*, 2238, 2239 (Tu-Phap).

60144 60. M. CUBITTI, *Dunn*, sp. n.

Arbor 8 m. alta, vel ? frutex scandens magna, præter flores glabra, ramulis primo lævibus tandem griseis rugulosis. *Folia* 5–8-juga, 25–35 cm. longa, petiolo 6-plo longiora; stipulæ lineares, persistentes; foliola superiora lateralia anguste oblongo-oblanceolata, acuminata, basi rotundata, 8–10 cm. longa, papyracea, venis marginem approximantibus 7–9-paribus infra tandem prominulis; petioluli 4–5 mm. longi; stipellæ setaceæ, 1–1·5 mm. longæ.

Paniculæ racemiformes, secus apices ramulorum axillares, 10–20 cm. longæ; nodi floriferi pedunculati, pedunculis ad 1·4 cm. longis, pauciflori. *Flores* fasciculati, 2·0–2·3 cm. longi; pedicelli glabri, 8 mm. longi; bracteæ bracteolæque minutæ. *Calyx* patulus, 6–7 mm. longus, præter marginem tomentosam fere glaber, dentibus brevibus inconspicuis. *Petala* lilacina; vexilli lamina rotundata, versus apicem pubescens, basi cordata, auriculis minute inflexis, etiam fortiter bicornuta, ungue 3–4-plo longior; alæ carinæque petala anguste oblongæ, basi truncatæ. *Stamina* monadelpha, vexillare basi solutum. *Discus* nullus. *Ovarium* lineare, sericeum, multiovulatum. *Legumen* lineare, paullo curvatum, suturis paullo incrassatis, 18 cm. longum, 2·5 cm. latum, valvis lignosis elasticis tandem glabris liberis. *Semina* 5.

Flowers April to July.

UPPER BURMA, *Cubitt*, 226, and *Lace*, 5730 (Bhamo), *Smales.*

SHAN STATES, *Collett*, 620 (3000 ft.).

CHINA: Yunnan, *Henry*, 10939 (Red River Valley, Manpan at 3000 ft.).

61. M. NIVEA, *Dunn*, sp. n.

Arbor parva, præter flores omnino glabra, cortice pallido rugoso. *Folia* 3–4-juga, 25–40 cm. longa, petiolo 7-plo longiora; stipulæ 0; foliola superiora lateralia oblonga, caudata, basi obtusa, 10–20 cm. longa, papyracea, utrinque reticulata, venis marginem appropinquantibus 8–10-paribus; petioluli 4 mm. longi; stipellæ nullæ. *Paniculæ* racemiformes, axillares, 12–15 cm. longæ; nodi floriferi ad 3 mm. longi, 3–4-flori, puberuli. *Flores* fasciculati, 2·0 cm. longi; pedicelli 0·5 mm. longi; bracteæ bracteolæque nullæ. *Calyx* campanulatus, 5 mm. longus, extus breviter adpresse sericeus, dentibus 4 tubo bis brevioribus, superiore latiore apice emarginato intus breviter tomentosis. *Petala* alba, glabra; vexilli lamina ovata, in unguem 2–3-plo breviorem subito angustata; alæ carinæque petala oblongæ, falcatæ. *Stamina* monadelpha, vexillare basi solutum. *Discus* nullus. *Ovarium* lineare, sericeum, multiovulatum.

SUMATRA: River Roepit at 300 feet, *Forbes*, 2916.

62. M. LEPTOBOTRYA, *Dunn*, sp. n.

Arbor 8–10 m. alta, ramulis primo tenuiter velutinis tandem glabris pallidis rugosis. *Folia* 4-juga, ad 50 cm. longa, petiolo 5–6-plo longiora, rachi ut foliolis mox glabra; stipulæ parvæ, 2 mm. longæ, ovatæ, persistentes; foliola lateralia superiora lineari-oblonga, acuminata, basi obtusa, 20–25 cm. longa, chartacea, supra nitida, infra opaca, supra leviter infra dense reticulata, venis marginem approximantibus 11–13-paribus patentibus; petioluli 5–6 mm. longi; stipellæ nullæ. *Panicula* angusta terminalis, 35–45 cm. longa, 4 cm. lata, rachi ut ramulis pedicellis calycibusque tenuiter pubescente; ramuli ad 1·5 cm. longi, ad basin floriferi. *Flores* albi, 1·1–1·2 cm. longi; pedicelli

1·5 mm. longi; bracteæ bracteolæque lineares, 1 mm. longæ, deciduæ. *Calyx* campanulatus, 5 mm. longus, pubescens, dentibus 4 tubo æquilongis lanceolatis, superiore bidentato. *Petala* glabra; vexilli lamina rotundata, basi sagittata, exauriculata, ungue 4-plo breviore; alæ oblongæ falcatæ; carinæ petala conformia. *Stamina* monadelpha, vexillare basi solutum introrsum arcuatum. *Discus* calyci adnatus, apice crenulatus. *Ovarium* sericeum, multiovulatum, lineare. *Legumen* lineari-oblongum, 7–20 cm. longum, 3·5–4 cm. latum, 1–3-spermum, tenuiter sericeum, tandem glabrum, elastice dehiscens. *Semina* lentiformia, fusca.

CHINA: Yunnan, Szemao, *Henry*, 12792, 12792 A, *Bons d'Anty*, 244, 251.

63. M. ALBIFLORA, *Prain in Journ. As. Soc. Beng.* lxvi. II. (1897) 92, 364; *Ann. Calc. Bot. Gard.* ix. I. t. 31.

Arbor magna, ad 34 m. alta, præter panicula glabra, cortice pallido lævi. *Folia* (1–)2–3-juga, 30 cm. longa, petiolo 5–6-plo longiora; stipellæ nullæ; foliola elliptico-lanceolata, caudato- vel obtuse acuminata, basi cuneata, 15–25 cm. longa, coriacea, reticulata, venis marginem appropinquantibus 6–9-paribus infra prominulis; petioluli 4–5 mm. longi; stipellæ nullæ. *Paniculæ* sæpe versus apicem ramulorum aggregatæ, 20–40 cm. longæ, rachi superiore ut pedicellis calycibusque breviter tomentosa; ramuli floriferi multiflori, ad 15 cm. longi. *Flores* distantes, singuli, 1·5–1·9 cm. longi; pedicelli 4–5 mm. longi; bracteæ parvæ caducæ. *Calyx* campanulatus, 7 mm. longus, fuscobrunneus, lucens, intus præter tubum breviter tomentosus; bracteolæ orbiculares, 4 mm. longæ. *Petala* glabra, nivea; vexilli lamina orbicularis, basi subcordata, medio bicallosa, ungue 3–4-plo longior; alæ et carinæ petala oblongæ, basi truncatæ. *Stamina* monadelpha, vexillare basi, vel tandem omnino, liberum, paullo perigyna. *Discus* calyci adnatus. *Ovarium* sericeum, lineare, multiovulatum. *Legumen* oblanceolatum, ad 25 cm. longum, 4·5 cm. latum, dense nigro-velutinum (siccitate brunneum), elastice dehiscens, valvis coriaceis inter semina liberis.

Flowers May to October, fruits November to June.

MALAY PENINS.: Penang, *Curtis*, 2459 (old pass to Nalin); Perak, Ulu Salama, *Kunstler*, 6077, 5993, 5833, 4467, 729 (*types*), 4201, *Scortechini*, 1288 (*type*); Perak, Larut, *Kunstler*, 5357, 6709, 6842 (*types*); Perak, Goping, *Scortechini*, 1948 (*type*); Perak, *Wray*, 1864 (Thaipeng Plains (*type*), 1943 (Kota Plains, *type*); Selangor, *Ridley*, 8598, 10596; Pahang, *Ridley*, 2641 (*type*); Malacca, *Maingay* 1191 (Kew Dist. 606).

64. M. UNIFOLIATA, *Prain*, *l. c.* 93, 364; *Ann. Calc. Bot. Gard.* ix. I. t. 30.

Arbor 6–10 m. alta, præter paniculam glabra, cortice griseo rugoso. *Folia* simplicia, nunquam vere composita, lanceolata vel lineari-lanceolata, acuta vel breviter et obtuse acuminata, basi cuneata, 12–20 cm. longa, coriacea, reticulata, venis marginem approximantibus 9–13-paribus infra prominentibus; petioluli 4–5 mm. longi; stipulæ nullæ. *Paniculæ* axillares et terminales, nonnunquam versus apicem ramulorum collecti et paniculam generalem formantes, 10–15 cm. longæ, apice racheos pedicellis calycibusque brevissime denseque velutinis; nodi floriferi sessiles vel in ramulos ad 3 cm. longos elongati, multiflori. *Flores* 1·5 cm. longi; pedicelli 3–4 mm. longi; bracteæ nullæ; bracteolæ 1–1·5 mm. longæ, lanceolatæ, deciduæ. *Calyx* campanulatus, 8 mm. longus, extus breviter sericeus, dentibus 4 tubo æquilongis superiore bifido. *Petala* glabra, alba; vexilli lamina rotundata, basi sagittata, medio bicallosa; alæ carinæque petala oblongæ, leviter falcatæ. *Stamina* monadelpha, vexillare basi solutum. *Discus* nullus. *Ovarium* breviter sericeum, 5-ovulatum. *Legumen* lineare, ad 12 cm. longum, 2·5 cm. latum, dense breviter olivaceo-velutinum, elastice dehiscens, valvis tenuiter lignosis, inter semina liberis.

Flowers in June and July; fruits ripe in the following June.

MALAY PENINS.: Pangkore Is., *Curtis*, 1615 (*type*), *Scortechini*, 1023 (*type*); Blanja, *Scortechini*, 124, 1711 (*types*); Perak, *Ridley*, 7981, 8004, *Kunstler*, 4267, 4251 (Larut, *type*), 4492 and 8210 (Goping, *types*), *Wray*, 2836.

JAVA, *Horsfield*, 48.

65. M. CORUSCANS, *Dunn in Journ. Bot.* xlix. (1911) 220.

Arbor 8 m. alta, cortice primo velutino, tarde glabro. *Folia* (2–)3-juga, 15–20 cm. longa, petiolo 8–10-plo longiora; stipulæ caducæ; foliola leteralia superiora oblongo-ovata, acuminata, basi rotundata vel subcordata, 9–12 cm. longa, coriacea, supra nitida, reticulata, subtus dense adpresse sericea, splendida, tandem (in fructu) paullo glabrescentia, venis marginem appropinquantibus 16–20-paribus divergentibus approximatis utrinque prominulis; petioluli 3–5 mm. longi; stipellæ minutæ. *Panicula* terminalis, ramosa, basi foliosa, 15–20 cm. longa, ramis racemiformibus; ramuli floriferi ad 2·5 cm. longi, ut raches calycesque dense velutini (siccitate brunnei). *Flores* approximati, 1·4–1·7 mm. longi; pedicelli 1 mm. longi; bracteæ ramulorum et florum et bracteolæ oblatæ, 1 mm. longæ. *Calyx* campanulatus, extus sericeus, dentibus tubo æquilongis anguste triangularibus, superiore latiore bifido. *Petala* alba? glabra; vexilli lamina rotundata, in basi bicallosa, sagittata, auriculis inflexis; alæ oblongæ, valde falcatæ, transverse rugosæ; carinæ petala ovato-oblonga, falcata. *Stamina* monadelpha, vexillare basi solutum. *Discus* calyci adnatus, apice breviter fimbriatus. *Ovarium* lineare, longe acuminatum, multiovulatum. *Legumen* lineari-oblongum, utrinque obtusum, 11 cm. longum, 3 cm. latum, dehiscens, suturis incrassatis, brunneo-sericeum.

Flowers in August, fruits September.

KAMERUN: Gross Batanga, *Linklage*, 785.

SPANISH GUINEA: Rio Muni, *Mann*, 1743

66. M. HARMSIANA, *De Wild. in Ann. Mus. Congo*, sér. 5, i. 139, ii. 37, 147.—M. Ulbrichiana, *Harms in Engl. Jahrb.* xlv. (1910) 309; *Dunn in Journ. Bot.* xlix. (1911) 220.

Arbor parva? ramulis lenticellatis rugosis. *Folia* 4-juga, 20–30 cm. longa, rache breviter ferruginea, breviter petiolata; stipulæ caducæ; foliola superiora lateralia oblongo-obovata, breviter acuminata, basi rotundata, 8–10 cm. longa, papyracea, supra glabra, subtus tenuiter adpresse aureo-sericea, venis 9–12-paribus utrinque inconspicuis; petioluli 4 mm. longi; stipellæ obscuræ, 1–2 mm. longæ. *Paniculæ* racemiformes ad apicem ramulorum axillares et paniculam ramosam terminalem supra eos formantes; ramuli floriferi sessiles, 3–5 mm. longi. *Flores* conferti, 1·2–1·3 cm. longi; pedicelli ad 1 mm. longi. *Calyx* anguste campanulatus, 5 mm. longus, dense purpureo-sericeus dentibus tubo fere æquilongis; bracteolæ oblatæ, 1·5 mm. longæ, basin calycis amplectentes. *Petala* alba, glabra; vexilli lamina rotundata, basi sagittata, auriculis inflexis, ungue paullo longior; alæ carinæque petala falcatæ. *Stamina* monadelpha, vexillare basi solutum. *Discus* fimbriatus. *Ovarium* sericeum, 5-ovulatum, longe acuminatum.

Flowers in January.

CONGO FREE STATE: Kamuenza, *Gillet*, 1919 (fide *De Wild.*).

SPANISH GUINEA, *Tessmann*, B 136 (450 m.).

The var. *acuminata*, De Wild. *l. c.* ii. 147, is said to differ from the type in having its leaflets rounded or nearly subcordate at the base and acuminate at the tip.

67. M. DUCHESNEI, *De Wild. Ann. Mus. Congo*, sér. 5, i. 138.

Frutex ramis pubescentibus mox glabris paullo lenticellatis. *Folia* 3-juga, 25–35 cm. longa, petiolo 4-plo longiora, rachi glabra; stipulæ 8–10 mm. longæ, oblongo-lineares paullo infra medium affixæ, deciduæ; foliola superiora lateralia ovato-oblonga, breviter acuminata, acumine truncato vel retuso, basi rotundata, chartacea, supra subglabra, opaca, infra tenuiter et brevissime adpresse hirsuta, venis marginem appropinquantibus 7-paribus arcuatis subtus prominulis; petioli 5 mm. longi; stipellæ setaceæ, 2–3 mm. longæ. *Panicula* racemiformis, terminalis, 16–20 cm. longa, rachi pubescente; nodi floriferi breves. *Flores* fasciculati, 3–4-ni, 1·8 cm. longi; pedicelli 2 mm. longi. *Calyx* 1 cm. longus, anguste campanulatus, adpresse sericeus; dentibus anguste lanceolatis tubum æquantibus; bracteolæ lineares, 1 cm. longæ. *Petala* glabra, violascentia; vexilli lamina rotundata, basi transverse callosa; alæ carinæque petala oblongæ, falcatæ. *Stamina* diadelpha. *Discus* nullus.

Flowers in December.

CONGO FREE STATE: Stanleyville, *Duchesne*, 4.

The flowers of the type specimen examined were not fully expanded.

68. M. Solheidii, *De Wild. in Ann. Mus. Congo*, sér. 5, iii. 204.

Frutex? cortice pallido rugoso. *Folia* 3-juga, 15–25 cm. longa, rachi tenuiter pubescente, petiolo 3–5-plo longiora; stipulæ caducæ; foliola superiora lateralia breviter acuta, basi rotundata, 6·5–7·5 cm. longa, papyracea, supra glabra, subtus brevissime sericea, venis marginem appropinquantibus circiter 9-paribus; petioluli 3–4 mm. longi; stipellæ setaceæ, 2–3 mm. longæ. *Paniculæ* racemiformes, 10–16 cm. longæ, axillares et terminales, vel paniculam magnam 20–40 cm. longam ramosam paucifoliatam lateralem formantes; rachis pubescens; nodi floriferi 2–5 mm. longi. *Flores* fasciculati, 1·3 cm. longi; pedicelli 1–1·5 mm. longi ut calyces dense brunneo-velutini; bracteæ parvæ, caducæ. *Calyx* anguste campanulatus, 7 mm. longus, dentibus tubo æquilongis; bracteolæ ovatæ, 1 mm. longæ, deciduæ. *Petala* glabra; vexilli lamina ovata, basi breviter cordata, auriculis inflexis, ungue bis breviore; alæ carinæque petala oblongæ, falcatæ. *Stamina* monadelpha, vexillare basi solutum? *Discus* calyci adnatus. *Ovarium* lineare, sericeum, multiovulatum.

Congo Free State, near Yambuya, *Solheid*.

69. M. fulgens, *Dunn in Journ. Bot.* xlix. (1911) 220.

Arbor parva? cortice primo velutino. *Folia* 6-juga, 13–17 cm. longa, petiolo 5–7-plo longiora, rachi laxe adpresse sericea; stipulæ lineares, 3 mm. longæ, deciduæ; foliola lateralia superiora oblongo-lanceolata, acuminata vel acuta, apiculata, 2·5–4 cm. longa, papyracea, supra nitida fuscescentia, subtus adpresse sericea, siccitate cuprea, splendida, venis marginem approximantibus 4-paribus, infra prominulis erecto-patentibus; petioluli 2 mm. longi. *Panicula* terminalis, 16–20 cm. longa, rachi ut ramulis bracteisque dense velutina; rami floriferi ad 5 cm. longi. *Flores* tandem distantes, 1·2–1·3 cm. longi; pedicelli 1 mm. longi; bracteæ ramulorum florumque anguste lanceolatæ, 4 mm. longæ, persistentes. *Calyx* campanulatus, 5 mm. longus, dense sericeo-velutinus, siccitate brunneo-purpureus, dentibus paullo tubo brevioribus. *Petala* glabra. *Legumen* immaturum oblongum, compressum, dense velutinum.

Flowers in August.

Congo Free State: M'bota, *Burton* (1863).

The only specimen known to me is in young fruit.

70. M. lucens, *Dunn, l. c.* 220.—Lonchocarpus lucens, *Scott Elliot in Journ. Linn. Soc., Bot.* xxx. (1894) 77.

Frutex ramis puberulis. *Folia* 5–6-juga, 15–20 cm. longa, petiolo 7-plo longiora, rachi adpresse tandem inconspicue sericea; stipulæ caducæ; foliola lateralia superiora oblongo-lanceolata, gradatim acuminata, basi obtusa, 5–7 cm. longa, chartacea, margine revoluta, supra lucida, glabra, subtus adpresse sericea (siccitate argentea), lucentia, venis marginem appropinquantibus, 9-paribus erecto-patentibus, infra prominulis; petioluli 3–4 mm. longi;

stipellæ caducæ. *Paniculæ* axillares, 20–25 cm. longæ, rachi ramulisque breviter velutinis; ramuli floriferi multi, ad 4 mm. longi. *Flores* approximati, sessiles, 1·2 cm. longi, bracteæ bracteolæque 1·5 mm. longæ, late ovatæ. *Calyx* anguste campanulatus, 5–6 mm. longus, dense sericeus, siccitate aureus, dentibus tubo paullo longioribus, superiore cæteris paullo longiore bidentato. *Petala* glabra; vexilli lamina ovata, basi callosa, sagittata, auriculis inflexis itaque eas alarum tenentibus, ungue 4-plo longior; alæ carinæque petala oblongæ, fortiter falcatæ. *Stamina* monadelpha, vexillare basi solutum. *Ovarium* lanceolatum, longe attenuatum, multiovulatum.

Flowers in December.

SIERRA LEONE: Samu Country, *Scott Elliot*, 4241.

71. M. UROPHYLLOIDES, *De Wild. in Ann. Mus. Congo*, sér. 5, ii. 147.

Frutex? ramulis breviter velutinis. *Folia* 3–4-juga, 15–17 cm. longa, rachi laxe pubescente, petiolo 4-plo longiora; stipulæ caducæ; foliola superiora lateralia ovato-oblonga, breviter et obtuse acuminata, basi rotundata vel subcordata, chartacea, supra glabra, reticulata, subtus adpresse sericea, venis marginem approximantibus 12–14-paribus fere patentibus infra paullo prominulis; petioluli 5 mm. longi. *Paniculæ* axillares et terminales, 10–15 cm. longæ, paniculam magnam terminalem foliosam formantes; ramuli floriferi 3–10 cm. longi, fere sessiles, velutini. *Flores* approximati, 1·5 cm. longi; pedicelli 3 mm. longi; bractæ caducæ. *Calyx* in pedicellum reflexus, 8 mm. longus, dense adpresse brunneo-sericeus, dentibus tubo æquantibus, superiore aliis paullo longiore bidentato ob vexillum refractum retroflexo; bracteolæ concoideæ, 3 mm. longæ. *Petala* glabra; vexilli lamina transverse callosa, sagittata, auriculis inflexis; alæ oblongæ, uncinatæ, transverse rugosæ; carinæ petala oblonga, subfalcata. *Stamina* monadelpha, vexillare basi solutum. *Discus* fimbriatus. *Ovarium* lineare, sericeum, multiovulatum.

Flowers in August.

FRENCH CONGO, *Laurent* (4.8.1901).

72. M. HYPOLAMPRA, *Harms in Engl. Jahrb.* xxxiii. (1902) 168; *Dunn in Journ. Bot.* xlix. (1911) 220.

Folia 3-juga, 30 cm. longa, rachi paullo ferruginea, petiolo 4-plo longiora; foliola lateralia oblonga, acute acuminata, apiculata, basi obtusa, 13–15 cm. longa, papyracea, supra glabra, subtus tenuiter adpresse argenteo-sericea, venis marginem appropinquantibus utrinque 16–18 rectis parallelis ascendentibus, infra prominulis; petioluli 6 mm. longi; stipellæ persistentes, 1 mm. longæ. *Paniculæ* ramuli floriferi 3–4 cm. longi, breviter sericei. *Flores* approximati, 1–1·2 cm. longi; pedicelli 1–2 mm. longi. *Calyx* anguste campanulatus, 7–8 mm. longus, dense fulvo-sericeus, dentibus tubo paullo brevioribus lanceolatis acutis, superioribus duobus dimidio connatis; bracteolæ basales, rotundatæ, ·75 mm. longæ. *Petala* glabra; vexilli lamina ovata, basi angustata, fortiter bicallosa, bihamata, ungue bis longior; alæ valde, carinæ petala paullo hamatæ. *Stamina* monadelpha, vexillare basi solutum. *Discus* parvus, fimbriatus. *Ovarium* breve, sericeum, in stylum longum glabrum abiens, 4-ovulatum.

S. Nigeria: Oban, *P. A. Talbot*, 578.

Kamerun, *Rudatis*, 13 (*type*).

73. M. Lecomtei, *Dunn in Journ. Bot.* xlix. (1911) 220.

Arbor? ramulis glabris lenticellatis. *Folia* 4-juga, 20–30 cm. longa, rachi pallida velutina, breviter petiolata; stipulæ breves, late triangulares; foliola superiora lateralia obovato-oblonga vel oblanceolata, subito acuminato-caudata, basi sæpe acuta, chartacea, supra glabra, subtus adpresse argenteo-sericea, venis 10–11-paribus infra paullo prominulis; petioluli 4–5 mm. longi; stipellæ minimæ. *Paniculæ* magnæ, ramosæ, terminales, 20 cm. longæ et latæ, breviter pedunculatæ, rachi ramisque pallide velutinis; ramuli floriferi sessiles, 1–3 cm. longi. *Flores* approximati, 1 cm. longi; pedicelli 1–2 mm. longi; bracteæ minutæ. *Calyx* anguste campanulatus, 5 mm. longus, brunneo-velutinus, basi bi-bracteolatus, dentibus tubo æquilongis; bracteolæ 1·5 mm. longæ, late triangulares. *Petala* glabra, alba; vexilli lamina rotundata basi auriculato-callosa, ungue bis longior; alæ oblongæ, hamatæ; carinæ petala ovata, uncinata. *Stamina* monadelpha, vexillare basi solutum. *Discus* calyci adnatus apice liber fimbriatus. *Ovarium* lanceolatum, sericeum, in stylum longum sensim angustatum, 4-ovulatum.

Flowers in February.

French Congo: Mazomba Lagoon, *Lecomte*, D 103 (*type*).

74. M. Dinklagei, *Harms in Engl. Jahrb.* xxvi. (1899) 287; *Stapf in Johnston, Liberia*, ii. 593.

Arbor cortice velutino mox glabra. *Folia* 4–6-juga, 15–25 cm. longa, rachi ut eis paniculæ breviter velutina; stipulæ caducæ; foliola lateralia superiora, oblongo-lanceolata, acuta vel breviter acuminata, basi obtusa, 4–7 cm. longa, chartacea, supra glabra, subtus adpresse sericea, splendida, venis marginem appropinquantibus 13–15-paribus divergentibus intra marginem inter se arcuatis, costa supra paullo impressa, omnibus subtus prominentibus; petioluli 2–3 mm. longi; stipellæ minimæ. *Panicula* terminalis, 15–20 cm. longa, ramosa, lata; ramuli floriferi 5–6 cm. longi. *Flores* tandem distantes, 1 cm. longi; pedicelli 0·5–1 mm. longi; bracteæ bracteolæque late ovatæ, 1 mm. longæ. *Calyx* angustus, 6 mm. longus, ferrugineo-velutinus, dentibus 5 æqualibus lanceolatis tubo æquantibus. *Petala* alba, glabra; vexilli lamina rotundata, basi transverse callosa, breviter cordata, auriculis inflexis, ungue 2–3-plo longior; alæ oblongæ, uncinatæ, transverse rugosæ ; carinæ petala oblonga hamata. *Stamina* monadelpha, vexillare supra basin liberum, basi cum petala breviter consolida. *Discus* nullus. *Ovarium* lanceolatum, sericeum, in stylum longum sensim abiens, 5-ovulatum. *Legumen* vix maturum, 8 cm. longum, 2·5 cm. latum, brunneo-velutinum.

LIBERIA : Grand Bassa, *Dinklage*, 1672, 1964 (*types*).

75. M. KLAINEI, *Dunn in Journ. Bot.* xlix. (1911) 220.

Frutex scandens, ramulis brunneis lenticellatis scabris. *Folia* 5-juga, 15–20 cm. longa, breviter petiolata, rachi tenuiter ferruginea ; stipulæ caducæ ; foliola lateralia superiora lanceolata, in acumen apiculatum longe angustata, basi rotundata, 5–9 cm. longa, chartacea, supra glabra, subtus adpresse aureo-sericea, lucida, venis marginem appropinquantibus 10-paribus nec supra nec infra prominentibus ; petioluli 2 mm. longi ; stipellæ nullæ. *Paniculæ* parvæ, terminales axillaresque, in ramorum apicibus ; ramuli floriferi sessiles, 2–4 cm. longi ut raches subsericei ; bracteæ ramulorum florumque ut bracteolæ, parvæ, rotundatæ, 1 mm. longæ, persistentes. *Flores* brevissime pedicellati, approximati, 9–10 mm. longi ; pedicelli ·8 mm. longi. *Calyx* turbinatus, 7 mm. longus, dense aureo-sericeus, dentibus ascendentibus lanceolatis tubo æquilongis, superioribus 2 liberis obtusis, cæteris acutis ; bracteolæ tubo 6-plo breviores. *Petala* glabra ; vexilli lamina rotundata, basi transverse callosa, sagittata, ungue bis longior ; alæ carinæque petala oblongæ, hamatæ. *Stamina* monadelpha, vexillare basi solutum. *Discus* fimbriatus. *Ovarium* lanceolatum, sericeum, in stylum longum sensim abiens.

FRENCH CONGO : Gabun, *Klaine* (Herb. Paris et Berol., *types*).

76. M. AUREOCALYX, *Dunn, l. c.* 220.

Frutex scandens, cortice pallido glabro. *Folia* 4–5-juga, 20–30 cm. longa, rachi ut ea paniculæ et paginis inferioribus foliolorum molliter pubescente ; stipulæ caducæ ; foliola lateralia superiora anguste oblonga, apice obtusa vel breviter acuminata, basi rotundata, 6–7 cm. longa, papyracea, supra pallida, nitentia, subtus reticulata, venis marginem appropinquantibus 8-paribus ascendentibus infra prominentibus ; petioluli 1–2 mm. longi ; stipellæ persistentes, setaceæ, 1 mm. longæ. *Paniculæ* terminales, 8–10 cm. longæ ; ramuli floriferi sessiles, patentes, ad 5 cm. longi, ut calyces dense velutini. *Flores* approximati, 1·8 cm. longi ; pedicelli 1–2 mm. longi ; bracteæ non visæ ; bracteolæ ovatæ, 1·5 mm. longæ. *Calyx* anguste campanulatus, 9 mm. longus, extus sericeus, dentibus tubo 4–5-plo brevioribus, 2 superioribus dimidio connatis. *Petala* glabra ; vexilli lamina rotundata, basi transverse callosa, cordata, auriculis inflexis, ungue bis longior ; alæ oblongæ, semihastatæ ; carinæ petala ovata, falcata. *Stamina* monadelpha, vexillare basi solutum. *Discus* in lobos 10 fimbriatus. *Ovarium* lanceolatum, in stylum longum angustatum.

Flowers in March.

French Guinea : Labé, *Chevalier*, 12378, 12399 (*types*).

77. M. bipindensis, *Harms in Engl. Jahrb.* xxxiii. (1902) 169 ; *Dunn in Journ. Bot.* xlix. (1911) 220.

Arbor? cortice mox glabro rugoso. *Folia* 6–8-juga, 20–30 cm. longa, rachi glabra ; stipulæ caducæ ; foliola lateralia superiora anguste oblonga, caudata, basi obtusa, 7–8 cm. longa, papyracea, supra glabra, subtus tenuiter et obscure adpresse sericea, venis marginem appropinquantibus 8-paribus divergentibus, nec supra nec infra prominentibus ; petioluli 3–4 mm. longi ; stipellæ persistentes, setaceæ, 1 mm. longæ. *Panicula* terminalis, angusta, 16–20 cm. longa, rachi primo breviter velutina ; ramuli floriferi 5 mm. longi, siccitate ut calyces purpureo-velutini. *Flores* 1·6 cm. longi ; bracteæ caducæ ; bracteolæ late ovatæ, 1 mm. longæ ; pedicelli 1·5–2 mm. longi. *Calyx* campanulatus, dense adpresse sericeus, 7–8 mm. longus, dentibus tubo æquilongis. *Petala* glabra ; vexilli lamina rotundata, basi bicallosa, auriculata, auriculis minutis inflexis ; alæ carinæque petala oblonga, uncinata. *Stamina* monadelpha, vexillare basi solutum. *Ovarium* oblongo-lanceolatum, sericeum, 5-ovulatum.

Kamerun : Bipinde, *Zenker*, 2299 (*type*).

6154 78. M. melanocalyx, *Dunn*, nom. nov.—Lonchocarpus macrostachyus, *Hook. f. in Hook. Nig. Fl.* 317. M. macrostachya, *Dunn in Journ. Bot.* xlix. (1911) 220, non *Coll. et Hemsl.*

Frutex scandens, 5 m. altus, cortice dense lenticellato. *Folia* 2-juga, 25–35 cm. longa, petiolo 5-plo longiora, rachi glabra ; stipulæ caducæ ; foliola lateralia superiora obovata, obtuse breviter acuminata, basi rotundata, 13–17 cm. longa, chartacea, supra glabra, infra tenuiter obscure adpresse sericea, utrinque paullo reticulata, venis marginem appropinquantibus 12-paribus erecto-patentibus infra prominulis ; petioluli 5 mm. longi ; stipellæ minutæ. *Paniculæ* terminales et axillares, inflorescentias magnas ad 70 cm. longas formantes, basi paullo ramosæ, rachi ut ramulis fusco-velutina ; ramuli floriferi ad 6 cm. longi. *Flores* primo approximati, 1·4–1·5 cm. longi ; pedicelli ·5–1 mm. longi ; bracteolæ late ovatæ, 1·5 mm. longæ. *Calyx* anguste campanulatus, adpresse nigro-sericeus, dentibus tubo 7–8-plo brevioribus. *Petala* alba vel albo-viridula, glabra ; vexilli lamina rotundata, basi bicallosa, inter callos stamen vexillare tenens, breviter cordata ; alæ oblongæ, falcatæ, transverse rugosæ ; carinæ petala oblongo-ovata, falcata. *Stamina* monadelpha, basi cum petalis consolida et vexillare ibi solutum. *Discus* calyci adnatus, apice lobatus. *Ovarium* lineare, in stylum longum abiens, sericeum, multiovulatum.

NIGERIA, *Vogel* (on the Quorra at Ibaddi, *type*), *Farquarson*, 70 (N. Nigeria).

KAMERUN: Barombi, *Preuss*, 411.

In dealing with Vogel's plant the younger Hooker was doubtful, in the absence of fruit, whether to place it in *Lonchocarpus* or *Millettia*. Numerous species have since come to Europe from this and neighbouring regions having similar habit and its peculiar floral characters. Some of them have typical *Millettia* fruit, and they have been distinguished as a section of that genus (*Efulgentes*), with this plant among them.

79. M. PORPHYROCALYX, *Dunn in Journ. Bot.* xlix. (1911) 220.

Frutex scandens ?, cortice primo tenuiter rufo-hirsuto. *Folia* 5-juga, 15–20 cm. longa, rachi ut costa sub foliolis tenuiter pilis vineis vestita; stipulæ triangulares, 2–3 mm. longæ, persistentes; foliola superiora lateralia oblanceolata, apice brevissime acuminata, basi rotundata, 6–7 cm. longa, papyracea, supra pallida, nitentia, subtus leviter reticulata, breviter et tenuiter adpresse sericea nec lucentia, venis marginem appropinquantibus 10–12-paribus erecto-patentibus infra prominulis; petioluli 1–1·5 mm. longi; stipellæ persistentes, 2–3 mm. longæ, setaceæ. *Paniculæ* terminales, 20–30 cm. longæ; ramuli floriferi ad 10 cm. longi, ut rachi laxe vineo-hirsuti. *Flores* primo approximati, 1·3 cm. longi; pedicelli 1–2 mm. longi; bracteæ obscuræ; bracteolæ ovatæ, 1·5 mm. longæ ut calyces pilis longis rubro-purpureis dense velutini. *Calyx* anguste campanulatus, dentibus 3–4-plo tubo brevioribus triangularibus. *Petala* glabra; vexilli lamina rotundata, basi fortiter bicallosa, sagittata, auriculis inflexis; alæ oblongæ, hamatæ, transverse rugosæ; carinæ petala ovata, falcata. *Stamina* petalis ima basi coalita, monadelpha, vexillare ibidem solutum. *Discus* fimbriatus. *Ovarium* lanceolatum, in stylum longum abiens, pubescens, 4-ovulatum.

Flowers in March.

FRENCH GUINEA: Entre la Koukouré et Timbo, *Chevalier*, 12507 (*type*).

79 *a*. M. RHODANTHA, *Baill. Adans.* vi. 223; *Baker in Oliver, Fl. Trop. Afr.* ii. 131 (p. p.).

Arbor 10–12 m. alta, cortice pallido rugoso; gemmæ compressæ, acutæ, striatæ, ramulis pendulis. *Folia* (4–)5–6-juga, ad 20 cm. longa, petiolo 6–7-plo longiora, rachi ut pagina inferiore præcipue costa foliolorum et racemis pube brevi fulvescente dense obsita; stipulæ caducæ; foliola superiora lateralia lanceolata, basi cuneata, apice acuta vel acuminata, 4–6 cm. longa, papyracea, præter costa mox glabra, siccitate subtus glauca, venis marginem approximantibus 10–12-paribus, erecto-patentibus haud prominentibus; petioluli 2–3 mm. longæ; stipellæ persistentes, 3 mm. longæ, setaceæ. *Paniculæ* racemiformes axillares et in caule summo fasciculatæ, nutantes, 12–20 cm. longæ, fere ad basin floriferæ; nodi floriferi 2–7 mm.

longi, sessiles. *Flores* in nodis 2–4-nim fasciculati, 1·4–1·5 cm. longi, rosei, odorati; bracteæ bracteolæque caducæ; pedicelli 3 mm. longi, graciles. *Calyx* campanulatus, brevissime villosulus, dentibus 4, superiore paullo longiore bidentato, tubo fere æquilongis. *Petala* glabra; vexilli lamina ovata, ad basin saggitatam contracta, basi paullo bicallosa, ungue 3–4-plo breviore; alæ carinæque petala oblonga basi truncatæ. *Stamina* monadelpha, vexillare basi solutum. *Discus* nullus. *Ovarium* lineare, sericeum, multiovulatum.

Flowers in March and April.

SENEGAMBIA, *Heudelot* 815 (Rio Nunez, *type*).

SIERRA LEONE, *Morson*, *Lane Poole*, 6.

IVORY COAST: Moyenne Sassandra, Soubré, *Chevalier*, 19110.

80. M. CHRYSOPHYLLA, *Dunn in Journ. Bot.* xlix. (1911) 220.

Arbor, 15 m. alta, ramulis lenticellatis. *Folia* 3(2–4)-juga, 20–30 cm. longa, rachi glabrescente, petiolo 4-plo longiora; stipulæ caducæ; foliola superiora lateralia ovato-oblonga, ad apicem obtusum paullo angustata, basi obtusa, 6–14 cm. longa, chartacea, supra glabra, subtus adpresse aureo-sericea, venis 10–14-paribus subtus prominulis; petioli 3–5 mm. longi; stipellæ nullæ. *Paniculæ* terminales, 10–25 cm. longæ, laxæ vel rarius congestæ, rachi breviter velutina; ramuli floriferi 1–5 cm. longi. *Flores* approximati, 1·5–1·6 cm. longi; pedicelli 1·5 mm. longi; bracteolæ 1 mm. longæ, late ovatæ. *Calyx* anguste campanulatus, 5 mm. longus, dentibus tubo 3–5-plo brevioribus, extus sericeus. *Petala* alba, glabra; vexilli lamina rotundata, basi sagittata, auriculis inflexis uncos alarum tenentibus, ungue bis longior; alæ oblongæ, transverse rugosæ, uncinatæ; carinæ petala oblongo-ovata. *Stamina* monadelpha, basi cum petalis consolida, vexillare ibi solutum. *Discus* fimbriatus. *Ovarium* lineare, sericeum, multiovulatum.

Flowers, August.

IVORY COAST: Lower Cavally, *Chevalier*, 19895 (between Prolo and Bliéron).

FRENCH GUINEA: Kouria, Koukouré, *Chevalier*, 15002.

81. M. SCOTT-ELLIOTI, *Dunn*, *l. c.* 220.

Arbor, cortice griseo glabro. *Folia* 5–6-juga, 12–16 cm. longa, rachi ut pagina inferiore præcipue costa foliolorum et rachi paniculæ pilis longis rubiginosis laxe vestita; stipulæ caducæ; foliola lateralia superiora anguste oblonga, acuta, apiculata, basi obtusa, 4–6 cm. longa, papyracea, supra glabra, nitentia, venis marginem appropinquantibus 10–12-paribus erecto-patentibus infra prominulis; petioluli 1–2 mm. longi; stipellæ persistentes, setaceæ, 2 mm. longæ. *Panicula* terminalis, 8–10 cm. longa; rami floriferi ad 4 cm. longi. *Flores* approximati, 1 cm. longi; pedicelli 1·5 mm. longi; bracteolæ lanceolatæ, 1–1·5 mm. longæ. *Calyx* anguste campanulatus, 6 mm. longus, dense (siccitate) purpureo-velutinus, dentibus tubo 2–3-plo brevioribus. *Petala* glabra; vexilli lamina rotundata, basi callosa, cordata, auriculis inflexis; alæ oblongæ, uncinatæ, transverse rugosæ; carinæ petala, ovata, basi obtusa. *Stamina* monadelpha. *Discus* fimbriatus, lobis partim calyci adnatus. *Ovarium* sericeum, lanceolatum, in stylum angustatum, multiovulatum.

Flowers in March.

SIERRA LEONE: Talla Hills, *Scott Elliot*, 5126 A (near Mussaia).

82. M. WARNECKEI, *Harms in Engl. Jahrb.* xxx. (1901) 87; *Dunn in Journ. Bot.* xlix. (1911) 220.

Arbor 6–7 m. alta, ramulis diu pallidis glabris. *Folia* 5–6-juga, 8–13 cm. longa, breviter petiolata; stipulæ caducæ; foliola superiora lateralia ovato-oblonga, breviter acuta, basi rotundata, 2–5 cm. longa, chartacea, supra glabra, subtus molliter sericea, venis 8–10-paribus, infra prominulis; petioluli 2 mm. longi; stipellæ setaceæ, 2 mm. longæ. *Panicula* terminalis, 12–16 cm. longa, pedunculata; rachi ramisque velutinis; ramuli floriferi 4–5 cm. longi, sessiles. *Flores* in ramulis racemosi, 1·2–1·4 cm. longi; pedicelli 1·5 mm. longi; bracteæ caducissimæ. *Calyx* campanulatus, velutinus, 5–6 mm. longus. *Petala* rosea, glabra; vexilli lamina rotundata, basi callosa, sagittata, auriculis inflexis uncos alarum tenentibus, ungue duplo longior; alæ carinæque petala uncinatæ, oblongæ. *Stamina* monadelpha, vexillare basi solutum. *Discus* fimbriatus, 5-lobus. *Ovarium* sericeum, lineare, multiovulatum. *Legumen* lineare, dehiscens, ferrugineo-villosum, demum glabrescens, 3–7-spermum, 9–12 cm. longum, 1·8–2·3 cm. latum.

Flowers and pods in April.

TOGO: Bagidar, *Warnecke*, 108 (in "Parksteppe," *type*).

83. M. SAPINI, *De Wild. Compagnie du Kasai* (1910), 310.

Frutex scandens, cortice glabro pallido lenticellato. *Folia* 5-juga, 15–25 cm. longa, rachi tenuiter pubescente, petiolo 3-plo longiora; stipulæ caducæ; foliola superiora lateralia anguste oblonga, apice breviter acute acuminata, basi rotundata, 6–8 cm. longa, papyracea, supra glabra, subtus adpresse sericea, lucentia, venis marginem appropinquantibus 8–12-paribus infra prominulis; petioluli 3 mm. longi; stipellæ setaceæ, 1 mm. longæ. *Paniculæ* racemiformes vel pauciramosæ, axillares et terminales, 6–10 cm. longæ, rachi puberula; nodi floriferi, 1–2 mm. longi. *Flores* fasciculati, 1·2 cm. longi; pedicelli 1–2 mm. longi; bracteæ nullæ. *Calyx* anguste campanulatus, 4·5 mm. longus, dense breviter brunneo-sericeus, dentibus tubo paullo vel bis brevioribus; bracteolæ rotundatæ, 1 mm. longæ, persistentes. *Petala* glabra; vexilli lamina ovata, basi callosa, inflexo-auriculata, auriculis uncos longos alarum tenentibus; alæ oblongæ, longe uncinatæ; carinæ petala subfalcata. *Stamina* monadelpha, vexillare basi solutum. *Discus* calyci adnatus, breviter lobatus. *Ovarium* lineare, sericeum, multiovulatum.

Flowers in October.

Congo Free State: Kasai, *Sapin*, D 1 ("Liane des bois," *type*).

84. M. congolensis, *De Wild. et Durand in Bull. Herb. Boiss.* sér. 2, i. 15 (nomen); *Ann. Mus. Congo*, sér. 3, i. 61, sér. 5, i. 140; *Comp. de Kasai* (1910), 309; *Mission Laurent* (1905), 109.—M. macrophylla, *De Wild. et Durand in Compt. Rend. Soc. Bot. Belg.* xxxvii. 47 (non *Benth.* fide *De Wild. et Durand*).

Frutex 3-4 m. altus, præter inflosescentiam glaber, cortice lenticellato. *Folia* 3–4-juga, 40–50 cm. longa, petiolo 4-plo longiora; stipulæ parvæ, oblongæ, deciduæ; foliola superiora lateralia elliptica, acuminato-caudata, basi rotundata, 14 cm. longa, papyracea, supra glabra, infra tenuissime pubescentia, reticulata venis marginem approximantibus 6-paribus; petioluli 5 mm. longi; stipellæ 1·5 mm. longæ, setaceæ. *Paniculæ* racemiformes, axillares, 25–35 cm. versus apicem velutinæ; nodi floriferi 3–6 mm. *Flores* conferti, 1·3 cm. longi; pedicelli 2 mm. longi, ut calyces breviter velutini; bracteæ bracteolæque minutæ. *Calyx* campanulatus, 4 mm. longus, dentibus brevibus. *Petala* glabra; vexilli lamina rotundata, basi obtusa ecallosa (?), apice obtusa, ungue 4–5-plo longior, medio viridula, margine rubido-brunnea, albo-lineata; alæ lineari-oblongæ, basi truncatæ, albæ, rubido-marginatæ; carinæ petala ovata, rostrata, subfalcata, alba. *Ovarium* pubescens, lineare. *Legumen* immaturum obovato-oblongum, brunneo-velutinum, suturis incrassatis.

Congo Free State, *De Wevre*, 773 (*type*). Valée de la Djuma, Sanda, Sadi (*fide* De Wild. et Durand in Ann. Mus. Congo, sér. 5, i. 140).

Native name *Kifundi*, fide De Wild. and Durand.

85. M. Cabræ, *De Wild. in Ann. Mus. Congo*, sér. 5, i. 136.

Frutex 2–3 m. altus, ramulis hornotinis velutinis. *Folia* 3–4-juga, 15–20 cm. longa, rachi tenuiter adpresse sericea, petiolo 6-plo longiora; stipulæ breves, ovatæ, persistentes; foliola superiora lateralia oblonga, acuminata, basi rotundata, 6–7 cm. longa, papyracea, supra glabra, subtus adpresse tenuiter sericea, venis marginem appropinquantibus circiter 7-paribus infra prominulis; petioluli 2 mm. longi; stipellæ setaceæ, 1 mm. longæ. *Inflorescentia* (ramo singulo et forsan abnormali tantum viso) probabiliter panicula contracta, terminalis, ramis ut ramulis pedicellis calycibusque dense brunneo-purpureo-sericeis, bractea triangulari 5 mm. longa suffultis; ramuli floriferi 5–10 mm. longi. *Flores* conferti, 1·5 cm. longi; pedicelli 1 mm. longi; bracteæ ovatæ, persistentes, 1·5 mm. longæ. *Calyx* anguste campanulatus, 8 mm. longus, dentibus tubo bis brevioribus. *Petala* glabra, siccitate nigra, margine alba; vexilli lamina ovata, basi subcordata, auriculis pubescentibus erectis; alæ carinæque petala hamatæ. *Stamina* monadelpha, vexillare basi solutum. *Discus* fimbriatus. *Ovarium* lineare, sericeum, multiovulatum.

Flowers at beginning of wet season.

CONGO FREE STATE, *Cabra*, 110 (Forest of Inteba, *type*).

86. M. THOLLONI, *Dunn in Journ. Bot.* xlix. (1911) 220.

Frutex scandens, ramulis tenuiter ferrugineis. *Folia* 2-juga, 15–20 cm. longa, rachi sparse rubro-hirta, petiolo 4-plo longiora; stipulæ breves, lanceolatæ, persistentes; foliola superiora lateralia obovata, acuminata, basi rotundata, chartacea, supra præter venas glabra, opaca, subtus breviter sericea, venis utrinque 4–6 haud prominulis; stipellæ brevissimæ. *Paniculæ* racemiformes, terminales, 10–20 cm. longæ, breviter pedunculatæ, rachi velutina; nodi floriferi 2–4 mm. longi. *Flores* fasciculati, 1·5 cm. longi; pedicelli 1·5 mm. longi; bracteæ obsoletæ. *Calyx* campanulatus, 4 mm. longus, breviter velutinus, bracteolæ basales minutæ, lineares, caducæ. *Petala* glabra, violacea; vexilli lamina ovata, basi bicallosa, ungue 2–3-plo longior; alæ carinæque petala oblongæ, basi obtusæ. *Stamina* monadelpha, vexillare basi solutum, perigyna. *Ovarium* versus basin hirtum, lineare, 5-ovulatum.

Flowers in January.

FRENCH CONGO: Brazzaville, *Thollon*, 486 (marshes, *type*).

87. M. MACROURA, *Harms in Engl. Jahrb.* xxvi. (1899) 289; *Dunn in Journ. Bot.* xlix. (1911) 220.

Arbor 4–7 m. alta, ramulis lævibus striatis rubro-brunneis. *Folia* 4-juga, 30–40 cm. longa, omnino glabra, petiolo 3-4-plo longiora; stipulæ caducæ; foliola superiora lateralia ovata, obtuse acuminata, basi truncato-rotundata, 12 cm. longa, chartacea, utrinque leviter reticulata, venis 6–7-paribus arcuatis; petioluli 7–9 mm. longi; stipellæ nullæ. *Panicula* terminalis, racemiformis, 25–40 cm. longa, chartacea, utrinque leviter reticulata, venis 6–7-paribus arcuatis; petioluli 7–9 mm. longi; stipellæ nullæ. *Panicula* terminalis, racemiformis, 25–40 cm. longa, pedunculata, rachi brevissime ferruginea; nodi floriferi approximati, 5–7 mm. longi. *Flores* dense conferti, 1·0 cm. longi; pedicelli 2–3 mm. longi; bracteæ minutæ. *Calyx* campanulatus, 4 mm. longus, tenuiter adpresse ferrugineus, dentibus 2 superioribus fere ad apicem connatis, rotundatis, cæteris triangularibus acutis, tubo paullo brevioribus; bracteolæ minutæ, basales. *Petala* glabra, violacea; vexilli lamina ovata, basi bicallosa, cordata, auriculis inflexis, ungue fere bis longior; alæ carinæque petala oblongæ, uncinatæ. *Stamina* monadelpha, vexillare basi solutum. *Discus* nullus. *Ovarium* lineare, adpresse, ferrugineum, 4-ovulatum. *Legumen* oblongum vel oblanceolatum, 9 cm. longum, 2·3 cm. latum, subglabrum, dehiscens.

Flowers May, fruits August.

FRENCH CONGO: Kassa in the great forest near the banks of the Congo, *Chevalier*, 5081.

CONGO FREE STATE: Mukengi, *Pogge*, 838 (*type*).

88. M. DUBIA, *De Wild. in Ann. Mus. Congo*, sér. 5, i. 137.

Frutex? cortice rugoso albido, ramulis hornotinis velutinis. *Folia* 4-juga, 30 cm. longa, rachi tenuiter sericea, petiolo 4-plo longiora; stipulæ deciduæ; foliola superiora lateralia oblongo-lanceolata, gradatim acuminata, caudata, basi acuta vel obtusa, 10–12 cm. longa, papyracea, supra glabra, subtus tenuiter adpresse sericea, venis marginem approximantibus circiter 10-paribus, infra prominulis; petioluli 3–4 mm. longi; stipellæ setaceæ, 3–4 mm. longæ. *Panicula* racemiformis terminalis, rachi tenuiter velutina; nodi floriferi 2 mm. longi. *Ovarium* 7-ovulatum. *Legumen* subsessile, oblongum, breviter acuminatum, 9 cm. longum, 2·5 cm. latum, sericeum, elastice dehiscens; valvæ tenuiter lignosæ. *Semina* 2, lenticularia nigra, 1·0 cm. diametro.

CONGO FREE STATE: Valley of the Dzuma, *Gentil* (*type*).

89. M. STUHLMANNII, *Taub. in Engl. Pflanzenweld Ost-Afr.* C, 212; *Harms in Engl. Jahrb.* xxviii. (1900) 405; *Dunn in Journ. Bot.* xlix. (1911) 221; *Baker fil. in Journ. Linn. Soc., Bot.* xl. (1911) 54.—Lonchocarpus mossambicensis, *T. R. Sim in For. Fl. Portug. E. Afr.* 45, t. 53.

Arbor 20 m. alta, cortice sæpe papyraceo, aurantiaco, ramulis et foliolis primo pubescentibus mox glaberrimis. Gemmæ lenticulares. *Folia* 3–4-juga, 20–30 cm. longa; foliola ovali-obcordata, basi obtusa vel rotundata, 9–10 cm. longa, chartacea, supra glabra, subtus pallida, minute adpresse sericea, venis in nervum marginalem currentibus 7–10-paribus regularibus rectis ascendentibus subtus prominentibus; stipellæ magnæ petiolulos sæpe æquantes. *Panicula* terminalis, angusta, 20–35 cm. longa, rachi ramisque superne pubescentibus. *Flores* 2·6 cm. longa, in ramulis 3–4 cm. longis secus rachin laxe dispositi, ebracteati, singuli. *Calyx* campanulatus, pubescens, 12 mm. longus, dentibus ovatis tandem reflexis, supremo 5 mm. longo emarginato, aliis 3 paullo minoribus; pedicelli æquilongi. *Petala* glabra, cærulea; vexilli lamina ovata, basi cordata, auriculata, lineolata; alæ carinæque petala æquilongæ, basi truncatæ. *Stamina* monadelpha, vexillare basi solutum. *Discus* calyci adnatus, crenulatus. *Ovarium* stipitatum, sericeum, 4–5-ovulatum. *Legumen* magnum, lineare, ad 27 cm. longum, 4 cm. latum, glabrescens, lenticellatum, dehiscens, valvis lignosis inter semina cohærentibus. *Semina* complanata, 2 cm. longa, 1·5 cm. lata.

Flowers in November, fruit in March.

GERMAN EAST AFRICA: Kilwa, *Kirk*.

PORTUGUESE EAST AFRICA: *Kirk* (Livingstone's S. African Expedition,

14°–19° S. lat.) ; Gazaland, *Swynnerton*, 145, 146, 1396, 1428 ; Mozambique, *Vasse*, 297, *Stuhlmann*, 856, 868 (*types*), *Dawe*, 312, 511.

An important hard-wood timber of the S.E. tropical part of Africa, known to the native races as *Musala*, *Panga-panga*, *Chicuswa*, *Pangira*, and *Mpangeli*. Sim (*l. c.*) mentions that it is planted as a shade-tree from stem-cuttings along the roads at Quisico. It is frequent in M'Chopeo and Inhambane (extra-tropical) and abundant in the tropical forests of Quilimane, Magenja da Costa, and Nhamacurra.

90. M. Laurentii, *De Wild. in Belg. Colon.* 1904, 378 ; *Mission Laurent*, 109 ; *Notice Pl. Utiles Congo*, 341 ; *Ann. Mus. Congo*, sér. 5, i. 259, ii. 147 ; *Compagnie de Kasai*, 310 ; *Dunn in Journ. Bot.* xlix. (1911) 221.—M. Tessmanni, *Harms in Engl. Jahrb.* xlv. (1910) 310.

Arbor magna, cortice lenticellato, præter inflorescentiam glabra ; gemmæ lenticulares. *Folia* 6-juga, 30–40 cm. longa, petiolo 4-plo longiora ; stipulæ minutæ, caducæ ; foliola lateralia superiora oblonga, acuminata, caudata, basi acuta, ad 12 cm. longa, papyracea, siccitate nigrescentia, utrinque reticulata, venis marginem proxime appropinquantibus 8–9-paribus supra et subtus prominulis ; petioluli 5–8 mm. longi ; stipellæ nullæ. *Panicula* angusta terminalis, 25–35 cm. longa, rachi dense puberula ; ramuli floriferi 1·5–3 cm. longi, ut calyces dense adpresse aureo-sericei. *Flores* approximati, 1·9 cm. longi ; pedicelli graciles, 3–5 mm. longi. *Calyx* campanulatus, 7–8 mm. longus, dentibus oblongis tubo paullo longioribus ; bracteolæ 2–4 mm. longæ. *Petala* glabra, lilacina ; vexilli lamina rotundata, basi cordata et bicallosa, auriculis laminæ inflexis et callorum erectis, ungue bis longior ; alæ carinæque petala oblongæ, hamatæ. *Stamina* monadelpha, vexillare basi solutum. *Discus* calyci adnatus, apice lobulatus. *Ovarium* lineare, pubescens, multiovulatum. *Legumen* lineari-oblongum, apice acuminatum, basi angustatum, 15–25 cm. longum, 3·5–4 cm. latum, glabrum, dehiscens ; valvæ lignosæ.

Flowers March to October, fruit November.

Congo Free State : Leopoldville and Kutu, *Laurent* (*type*) ; Kasai region, *Bunge*, *Sapin*.

French Congo : Brazzaville, *Brazza and Thollon*, 78.

Spanish Guinea : Akonanga, *Tessmann*, 940, B 228.

Produces a fine ebony known as *M'Botu* in the Lower Congo district.

91. M. micans, *Taub. in Engl. Pflanzenw. Ost-Afr.* C, 212 ; *Dunn in Journ. Bot.* xlix. (1911) 221.

Arbor? cortice primo velutino. *Folia* 3–5-juga, 20–30 cm. longa, rachi ferruginea ; stipellæ persistentes, oblongæ, acutæ, 1 cm. longæ vel longiores peltate juxta basin affixæ ; foliola lateralia superiora oblonga, breviter acuminata, basi rotundata vel truncata et subcordata, 10–15 cm. longa, coriacea, supra pubescentia, venis tomentosis, subtus molliter tomentosa,

venis marginem appropinquantibus 8–10-paribus parallelis approximatis in nervum marginalem exeuntibus; petioluli 5–6 mm. longi; stipellæ fortiter setaceæ, 3 mm. longæ. *Paniculæ* racemiformes terminales, 20 cm. longæ, pedunculatæ, rachi ramulis pedicellis calycibusque dense velutinis; ramuli floriferi ad 2 cm. longi. *Flores* approximati, 3 cm. longi; pedicelli 1 cm. longi; bracteæ oblongæ, 2–3 mm. longæ, caducæ. *Calyx* campanulatus, dentibus 2–3-plo tubo brevioribus. *Vexilli* lamina ovata, basi subsagittata, medio auriculis erectis bicallosa, dorso longe sericeo-pilosa, ungue 3–4-plo breviore, basi stamen vexillare amplectente; alæ oblongæ, transverse rugosæ, longe uncinatæ; carinæ petala oblonga hamata. *Stamina* monadelpha, vexillare basi solutum. *Discus* fimbriatus, lobulis infra calyci adnatis supra breviter liberis pubescentibus. *Ovarium* lineare, in stylum longum attenuatum, pubescens, 4-ovulatum. *Legumen* oblongo-lineare, utrinque obtusum, elastice dehiscens, 14 cm. longum, 3·5 cm. latum, 1 cm. crassum, suturis leviter incrassatis; valvæ lignosæ, dense velutinæ. *Semina* circiter 6, ovato-lenticularia.

GERMAN EAST AFRICA, *Busse*, 65, *Stuhlmann*, 6750 (*type*).

92. M. VERSICOLOR, *Welw. ex Baker in Fl. Trop. Afr.* ii. 129; *Hiern, Cat. Welw. Afr. Pl.* i. 227; *De Wild. in Ann. Mus. Congo*, sér. 5, ii. 260, t. 47; *De Wild. in Notice Pl. Utile Congo*, 343; *De Wild. in Compagnie de Kasai*, 311; *Ficalho, Pl. Ut. Afr. Portug.* 132; *Dunn in Journ. Bot.* xlix. (1911) 221.—Lonchocarpus Dewevrei, *M. Micheli in Durand et De Wild. in Compt. Rend. Soc. Bot. Belg.* xxxvi. (1897) 68, t. 5 (fide *De Wild.*).

Frutex 1–2 m. altus vel rarius arbor parva, 4–7 m. alta, ramulis striatis glabris; gemmæ complanatæ. *Folia* 5-juga, 25–30 cm. longa, petiolo 5-plo longiora, rachi glabra; stipulæ caducæ; foliola lateralia superiora oblongo-lanceolata, acuminata, basi obtusa, 9–11(–18) cm. longa, papyracea, supra glabra, subtus adpresse pubescentia, venis marginem appropinquantibus 16-paribus erecto-patentibus approximatis parallelis in nervum marginalem exeuntibus infra prominulis; petioluli 2–3 mm. longi; stipellæ setaceæ, 2 mm. longæ. *Paniculæ* terminales, pedunculatæ, angustæ, 30 cm. longæ, rachi tenuiter pubescente; ramuli floriferi, ad 6(–10) cm longi, adpresse pubescentes. *Flores* approximati, 2 cm. longi; pedicelli 3–4 mm. longi, ut calyx vexillique dorsum indumento aureo-brunneo adpresso sericeo fulgentes. *Calyx* 6–7 mm. longus, dentibus brevibus latis. *Petala* glabra; vexilli lamina intus alba, rotundata, basi subcordata, medio duobus longitudinalibus callis contiguis notata; alæ carinæque petala purpureæ, oblongæ, subhamatæ. *Stamina* diadelpha, vexillare complanatum leviter cohærens. *Discus* calyci adnatus, annulo apice libero. *Ovarium* lineare, dense velutinum, 4-ovulatum. *Legumen* oblongum, velutinum, 7–13 cm. longum, 3–4 cm. latum, dehiscens, suturis incrassatis; valvæ lignosæ, inter semina paullo cohærentes. *Semina* 2–3, oblonga, compressa, 2 cm. longa, 1·3 cm. lata.

Flowers in January, fruits in July.

Congo: Brazzaville, *Chevalier*, 4112, 11377.

Angola, *Wetwitsch*, 1859 (*type*).

The tree produces a very hard and useful timber, and its inner bark is employed for binding. The Angolan tribes call it *Muzumbo.*

93. M. caffra, *Meissn. in Lond. Journ. Bot.* ii. (1843) 99; *Harvey & Sonder, Fl. Cap.* ii. 211; *Wood, Natal Pl.* t. 32; *J. R. Sim in For. Fl. Cape of Good Hope*, 203, t. 55; *Dunn in Journ. Bot.* xlix. (1911) 221.—Virgilia grandis, *E. Mey. Comm.* 1?

Arbor ad 40 m. alta, cortice griseo lenticellato; gemmæ compressæ striatæ. *Folia* 6-juga, 15–25 cm. longa, petiolo 5–6-plo longiora, rachi sulcata pubescente; stipulæ caducæ; foliola lateralia superiora anguste oblonga, sæpius apice obtusa vel rotundata, in apiculum brevem deflexa, nonnunquam breviter et obtuse acuminata, basi paullo obliqua, rotundata, 5–7 cm. longa, chartacea, supra glabra, subtus adpresse pubescentia, venis marginem appropinquantibus 14–16-paribus erecto-patentibus approximatis parallelis, in nervum marginalem excurrentibus infra prominulis; petioluli 3–4 mm. longi; stipellæ setaceæ, paullo longiores. *Paniculæ* terminales, pedunculatæ, cylindricæ, 20–25 cm. longæ, rachi puberula; rami floriferi ad 7 cm. longi, breviter velutini. *Flores* dense congesti, 2·0 cm. longi; pedicelli 3–4 mm. longi; bracteæ bracteolæque caducæ. *Calyx* campanulatus, dense adpresse sericeus, dentibus rotundatis tubo bis brevioribus. *Petala* purpurea; vexilli lamina rotundata, basi fortiter transverse callosa, dorso longe sericeo-piloso, ungue 4-plo longior; alæ carinæque petala ovatæ, valde uncinatæ. *Stamina* diadelpha, perigyna. *Discus* nullus. *Ovarium* lineari-lanceolatum, velutinum, 5-ovulatum. *Legumen* oblongum, brunneo-velutinum, suturis incrassatis, 15 cm. longum, 3·5 cm. latum, valvis lignosis tandem elastice tortis. *Semina* oblonga, 2 cm. longa, compressa.

Flowers in January.

S. Africa: Natal, *Plant*, 20, *Wood*, 326 (Inanda), 650, 1025 (Berea), *Sutherland* (common in Mimosa valleys), *Krauss*, 194 (*type*), *Gerrard*, 9 (Zululand); Cape Colony, *Webe* (Transkeian Conservancy).

In Museum No. I. in the Royal Botanic Gardens, Kew, are specimens of the wood and examples of tool-handles and other objects made from it. A fine photograph of the tree accompanies the exhibit. Sim (*l. c.*) declares the timber to be the best of all S. African woods, and with one exception the heaviest.

94. M. Sacleuxii, *Dunn in Journ. Bot.* xlix. (1911) 221.

Arbor duro-lignosa, cortice albida striata, ramulis angularibus sæpe complanatis, gemmis lenticularibus. *Folia* 3-juga, 30–50 cm. longa, petiolo 4-plo longiora, rachi glabra; stipulæ caducæ; foliola lateralia superiora late oblonga, apice subito et obtuse acuminata, 15 cm. longa, 7–9 cm. lata, chartacea, præter paginam inferiorem brevissime adpresse sericeam glabra, venis marginem appropinquantibus 15-paribus fere ad marginem rectis parallelis ascendentibus infra prominentibus; petioluli 6–7 mm. longi; stipellæ capillaceæ, 4 mm. longæ. *Paniculæ* parvæ, præcoces, terminales, ad 10 cm. longæ, sessiles, rachi tenuiter laxe ferruginea; ramuli pauciflori. *Flores* laxi, 3 cm. longi; pedicelli 1·0–1·4 cm. longi, breviter sericei; bracteæ deciduæ, lanceolatæ, membranaceæ, 1 cm. longæ. *Calyx* turbinatus, 1–1·2 cm. longus, dense purpureo-sericeus, dentibus tubo paullo brevioribus erectopatulis anguste triangularibus, superioribus 2 fere ad apicem connatis; bracteolæ basales bracteis omnino similes. *Petala* violacea?; vexilli lamina orbiculata, basi subcordata, reflexa, fortiter bicallosa, extus tenuiter sericea, unguem fere bis superans; alæ carinæque petala valde hamatæ. *Stamina* monadelpha. *Discus* calyci adnatus, apice crenulatus. *Ovarium* lineare, dense albo-tomentosum, 6-ovulatum. *Legumen* crassum, validum, 15–20 cm. longum, 4–5 cm. latum, 2–4-spermum, primo dense sericeo-tomentosum, glabrescens. *Semina* lenticularia.

Flowers from August to January, fruit ripe in July.

German East Africa: Mkonda, Ngourou, and Gagara, *Sacleux*, 2047, *Holtz*, 1227 (*types*).

95. M. Soyauxii, *Taub. in Engl. Jahrb.* xxiii. (1896) 185.

Frutex scandens, cortice primo ferrugineo-villoso, tandem glabro. *Folia* 3–5-juga, 10–14 cm. longa, petiolo 3–4-plo longiora, rachi ut foliolorum pagina inferiore ut rachi inflorescentiæ ut pedicellis et calycibus ferrugineo-villosa; stipulæ anguste lanceolatæ, acutæ, 6–8 mm. longæ, persistentes; foliola lateralia superiora oblanceolato-oblonga, breviter acuminata, basi rotundata, 4–6 cm. longa, chartacea, supra glabra, nitida, venis principibus 8–9-paribus arcuatis supra impressis infra prominentibus; stipellæ nullæ. *Paniculæ* racemiformes terminales et axillares, basi foliatæ, ad 20 cm. longæ; nodi floriferi breves globulares. *Flores* fasciculati, 1·8 cm. longi; pedicelli 2–3 mm. longi; bracteæ bracteolæque 1 cm. longæ, lineares. *Calyx* 3–4 mm. longus, dentibus tribus inferioribus tubo bis brevioribus duobus superioribus latioribus minoribus coalitis. *Vexilli* lamina ovata, dorso laxe adpresse villosa, in unguem brevem acuminata; alæ oblongæ, vexillo breviores, basi truncatæ, ungui æquales; carinæ petala ovata, longe unguiculata, subfalcata. *Stamina* monadelpha. *Discus* annularis. *Ovarium* lineare, sericeum, 6-ovulatum.

Flowers in July.

French Congo: Gabun, *Soyaux*, 96 (wood-borders from Zala to Tschinschoscho, *type*).

96. M. HIRSUTA, *Dunn*, sp. n.

Frutex scandens?, caulibus tenuiter pubescentibus mox glabris lenticellatis. *Folia* 3-juga, 20–25 cm. longa, petiolo 3–4-plo longiora, rachi laxe rufo-pilosa; stipulæ caducæ; foliola superiora lateralia obovata vel oblanceolata, breviter acuminata, basi obtusa, 8–12 cm. longa, papyracea, supra præter costas glabra, opaca, subtus longe laxeque sericeo-hirsuta, venis marginem appropinquantibus 7–8-paribus supra paullo impressis infra prominulis; petioluli 3 mm. longi; stipellæ setaceæ, 1–2 mm. longæ. *Paniculæ* racemiformes in axillis superioribus, 8–12 cm. longæ, rachi tomentosa; ramuli floriferi breves. *Petala* ignota. *Calyx* rufo-tomentosus. *Legumen* lineare, 8–12 cm. longum, 2 cm. latum, dense velutinum, dehiscens; valvæ crasse coriaceæ. *Semina* 1–5.

Fruits in December.

IVORY COAST, *Chevalier*, 16829 (Pont de l'Agbo at the 82nd kilo. of railway), 22640, 22644 (Région du Moyen-Comoe).

Distinguished from *M. Soyauxii*, Taub., by its conspicuous stipels.

97. M. GAGNEPAINIANA, *Dunn in Journ. Bot.* xlix. (1911) 221 (sphalm. *M. Gagnepaineana*).

Frutex parva scandens, apice longe flabelliformis, præter stipulis aphyllis nuda, cortice breviter rubiginosa. *Folia* (3–)4-juga, 20–25 cm. longa, petiolis quater longiora, rachi ut petiolulis breviter autem primo dense ferruginea; stipulæ persistentes, lineares, 0·7–1·2 cm. longæ; foliola lateralia superiora oblongo-obovata, basi rotundata, 5–10 cm. longa, papyracea, supra præter costam glabra, subtus tenuiter adpresse brunneo-sericea, venis 6–7-paribus rubiginosis infra prominentibus; petioluli 3–4 mm. longi; stipellæ nullæ. *Paniculæ* racemiformes, axillares vel supra folia oreuntes, pedunculatæ, ad 35 cm. longæ, rachi breviter ferruginea; nodi floriferi 2–3 mm. longi, bracteati. *Flores* fasciculati, 1·1–1·3 cm. longi; pedicelli 2 mm. longi; bracteæ lineares, 3 mm. longæ. *Calyx* campanulatus, 4 mm. longus, 3 mm. latus, dense brunneo-sericeus, dentibus tubo 3–4-plo brevioribus, superioribus duobus in unum late rotundatum emarginatum connati, cæteris triangularibus; bracteolæ basilares, 1 mm. longæ. *Petala* alba, luteo-tincta; vexilli lamina reflexa, rotundato-ovata, in unguem angustata, exauriculata, extus dense sericea; alarum laminæ apice sericeæ, bis longiores quam latæ, basi truncatæ; carinæ petala leviter falcata, ter longiora quam lata. *Stamina* monadelpha. *Discus* obsoletus. *Ovarium* oblongum, sericeum, 5-ovulatum.

Flowers in September.

FRENCH CONGO: Libreville, *Klaine*, 569 (*type*), *Burton* (Ma Kau Ka).

This beautiful climber is named after my friend M. Gagnepain, of the Museum d'Histoire Naturelle.

98. M. BICOLOR, *Dunn in Journ. Bot.* xlix. (1911) 221.

Frutex scandens, ramulis ut rachibus paginisque inferioribus foliolorum pilis longis rufis tenuiter vestita. *Folia* 4-juga, 20–30 cm. longa, petiolis 3–4-plo longiora; stipulæ lineares, 1–1·5 cm. longæ, persistentes; foliola superiora oblonga, obtuse acuminata, basi rotundata, 8–10 cm. longa, chartacea, supra glabra; petioluli 3–4 mm. longi; stipellæ nullæ. *Paniculæ* racemiformes terminales, 15–20 cm. longæ, ad basin et ad nodos bracteatæ; nodi floriferi globosi; bracteæ lineares, 0·8–1·0 cm. longæ, extus pilosæ; rachis breviter ferruginea; nodi floriferi 1–3 mm. longi. *Flores* fasciculati, 1·4 cm. longi; pedicelli 2 mm. longi, graciles. *Calyx* campanulatus, 4 mm. longus, dentibus 2 superioribus fere ad apicem coalitis, cæteris tubo 4–5-plo brevioribus, adpresse brunneo-pilosus; bracteolæ lineares, dimidium calycis æquantes. *Petala* alba, vexillo violascente; vexilli lamina rotundata in unguem brevem angustata, extus dense aureo-pilosa; alæ carinæque petala oblongo-ovatæ, basi truncatæ. *Stamina* monadelpha, vexillare basi solutum. *Discus* nullus. *Ovarium* lineare, pubescens, 4-ovulatum.

Flowers in September.

FRENCH CONGO: Kilabi, *Lecomte*, A 8 (*type*).

99. M. GOETZIANA, *Harms in Engl. Jahrb.* xxviii. (1899) 404; *Dunn in Journ. Bot.* xlix. (1911) 221.

Frutex volubilis, ramis primo hirsutis tandem glabris. *Folia* 3–4-juga, 6–30 cm. longa, petiolo 3–4-plo longiora, rachi tenuiter breviter hirsuta; stipulæ breves lanceolatæ; foliola superiora lateralia obovato-oblonga, breviter obtuse acuminata, rotundata vel emarginata, basi rotundata, 3–10 cm. longa, coriacea, tandem præter venas subtus paullo pubescentes omnino glabra, venis marginem approximantibus 6–8-paribus arcuatis supra impressis subtus prominentibus; petioluli 2–4 mm. longi; stipellæ setaceæ, 3–4 mm. longæ. *Paniculæ* racemiformes axillares et terminales, 20–30 cm. longæ, ad basin floriferæ, rachi præsertim superius breviter ferrugineo-velutina; nodi floriferi ad 5 mm. longi. *Flores* fasciculati, 1·0–1·3 cm. longi; pedicelli ut calyces tenuiter adpresse ferrugineo sericei, ad 2 mm. longi; bracteæ bracteolæque lineares, 3 mm. longæ. *Calyx* 6 mm. longus, dentibus 4, superiore lato emarginato, cæteris longioribus triangularibus tubo 3–4-plo brevioribus. *Vexilli* lamina rotundata, basi longitudinaliter bicallosa in unguem 3-plo breviorem subito contracta, dorso dense adpresse sericea; alæ oblongæ, basi truncatæ; carinæ petala apice paullo pubescentia, basi subhamata. *Stamina* monadelpha, vexillare basi solutum et ibi lateraliter compressum in unguem plicatam vexilli intrusum et retentum. *Discus* nullus. *Ovarium* lineare, sericeum, 6-ovulatum.

GERMAN EAST AFRICA: Usaramo, *Goetze*, 11 (*type*); Kilwa, *Kirk*.

100. M. IMPRESSA, *Harms in Engl. Jahrb.* xxvi. (1899) 288 ; *Dunn in Journ. Bot.* xlix. (1911) 221.

Frutex scandens, ramis primo ferrugineo-pubescentibus tandem glabris. *Folia* 3–4-juga, 15–20 cm. longa, petiolo 3–4-plo longiora, rachi laxe hirsuta ; stipulæ oblongæ, 3–4 mm. longæ, apice rotundatæ ; foliola lanceolato-oblonga, breviter obtuse acuminata, acumine retuso vel apiculato, basi rotundata, 6–8 cm. longa, coriacea, tandem glabra, venis marginem appropinquantibus 5–7-paribus arcuatis supra impressis subtus prominentibus ; petioluli 3–4 mm. longi ; stipellæ setaceæ, 2–3 mm. longæ. *Paniculæ* racemiformes axillares vel ramosæ terminales, ad basin floriferæ, rachi præsertim superius breviter ferrugineo-tomentosa ; nodi floriferi elongati, ad 3 mm. longi. *Flores* fasciculati, 1·2 cm. longi ; pedicelli 2 mm. longi ut calyx et dorsum vexilli breviter sed dense adpresse sericei ; bracteæ bracteolæque lineares, 1–2 mm. longæ. *Calyx* campanulatus, dentibus brevibus præter inferiorem acuminatum tubo bis breviorem. *Vexilli* lamina rotundata, basi medio longitudinaliter bicallosa, in unguem brevem acuminata ; alæ oblongæ, basi truncatæ ; carinæ petala apice pubescentia, subhamata. *Stamina* monadelpha, vexillare basi solutum. *Discus* nullus. *Ovarium* lineare, sericeum, multiovulatum. *Legumen* lineare, 6 cm. longum, 1·5 cm. latum, compressum, ferrugineo-hirsutum, dehiscens. *Semina* 2–4.

FRENCH CONGO : Loango, *Soyaux*, 99 (*type*).

CONGO FREE STATE, *Chr. Smith*, 38, 40, 43, 52, 74.

101. M. CALABARICA, *Dunn in Journ. Bot.* xlix. (1911) 221.

Frutex scandens, cortice glabro. *Folia* 3–4-juga, 15–50 cm. longa, petiolo 3-plo longiora, rachi primo ut rachibus panicularum pedicellis calycibus dorsisque vexillorum brevissime velutina tandem fere glabra ; stipulæ 2 mm. longæ, ovatæ ; foliola superiora lateralia obovata, breviter acuminata, basi rotundata, 7–20 cm. longa, coriacea, glabra, venis marginem appropinquantibus 7–8-paribus arcuatis supra impressis subtus prominentibus ; petioluli 4–8 mm. longi ; stipellæ nullæ. *Paniculæ* axillares, 15–25 cm. longæ, ad basin ramosæ ; nodi floriferi globosi, 1–2 mm. longi. *Flores* fasciculatæ, 1·2–1·5 cm. longæ ; bracteæ bracteolæque 1–1·5 mm. longæ, lanceolatæ. *Calyx* campanulatus, dentibus tubo 4–5-plo brevioribus. *Vexilli* lamina ovata, in unguem brevem acuminata, ecallosa ; alæ lineari-oblongæ, basi angustatæ ; carinæ petala basi truncata. *Stamina* monadelpha, vexillare basi solutum. *Discus* calyci breviter adnatus, apice crenulatus. *Ovarium* lineare, sericeum, multiovulatum.

NIGERIA : Old Calabar River, *Mann*, 2259 ; Oban, *P. A. Talbot* (*types*).

102. M. BARTERI, *Dunn, l. c.* 221.—M. urophylla, *Welw. ex Baker in Oliver, Fl. Trop. Afr.* ii. 129 (1871) ; *Hiern, Cat. Welw. Afr. Pl.* i. 228.

M. Demeusei, *De Wild. in Ann. Mus. Congo*, sér. 5, ii. 37. M. Gentilii, *De Wild. l. c.* 138, 258, t. liii.; *De Wild. Etude Fl. Bangala*, 323. Lonchocarpus Barteri, *Benth. in Journ. Linn. Soc., Bot.* iv. Suppl. 99 (1860); *Bot. Mag.* t. 6943; *Baker in Oliver, Fl. Trop. Afr.* ii. 243; *Baill. Adansonia*, vi. 222. L. Heudelotianus, *Baill. l. c.*

Frutex magnus scandens (nonnunquam arborescens?), ramis primo ferrugineo-pubescentibus mox glabris lenticellatis. *Folia* (2–)3–4-juga, 15–30 cm. longa, petiolo 2–3-plo longiora, rachi glabra vel rarius pubescente; stipulæ caducæ; foliola superiora lateralia ovato- vel obovato-oblonga, apice abrupte acuminata, acumine caudata emarginata, vel rarius gradatim acuminata, basi rotundata, 7–15 cm. longa, chartacea, glabra vel rarius, præcipue in costa, pubescentia, venis marginem approximantibus 7–9-paribus arcuatis infra prominentibus, petioluli 4–7 mm. longi; stipellæ nullæ. *Paniculæ* racemiformes, terminales et axillares, laxæ, 30–40(–80) cm. longæ, rachi ut pedicellis calycibusque breviter ferrugineo-velutinæ; nodi floriferi sæpius globulares, 1–2 mm. longi, rarius oblongi ad 4 mm. longi. *Flores* fasciculati, 1·2–1·4 cm. longi. *Calyx* 4–5 mm. longus, dentibus late triangularibus tubo 4–5-plo brevioribus. *Petala* rosea, sæpe violascentia; vexilli lamina ovata, in unguem brevem angustata, dorso pubescens; alæ lineari-oblongæ, basi truncatæ; carinæ petala, oblonga, subhamata. *Stamina* primo monadelpha, vexillare basi solutum mox omnino liberum. *Discus* breviter annularis. *Ovarium* pubescens, lineare, multiovulatum. *Legumen* oblongum, 4–7 cm. longum, 2 cm. latum, dense brunneo-velutinum, 1–2-spermum. *Semina* 2·5 cm. longum, 1·8 cm. latum.

Flowers February to May.

SENEGAMBIA: Rio Nunez, *Heudelot*, 803; *Chevalier*, 13174 (Guinée Française, Tarauna), 13244 (Haute Guinée Française, Valée de la Kaba), 18206 (Fonta Djallon, Kouria).

SIERRA LEONE, *Scott Elliot*, 4202.

LIBERIA, *Whyte*.

IVORY COAST: Bouroukrou, *Chevalier*, 16984.

NIGERIA, *Barter*, 67 (Brass River), 1609 (Nupe), 3253, 3401 (R. Obba, *types*), *Millson* (Yoruba), *Shaw*, 23 (Lokoya), *Mann*, 822 (Bagroo River), *W. C. Thomson*, 64 (Old Calabar), *Bowland* (W. Lagos).

KAMERUN, *Zenker*, 971, 1029, 2532, and 3266 (Bipindi), 1703, 2367, 3440, 3796, *Staudt*, 92, *Preuss*, 1187.

NIAMNIAM, *Schweinfurth*, 3189, 3227.

FRENCH CONGO, *Klaine*, 5, 69, *Lecomte*, D 97 (Mazomba), 723 (Poste de la Mission), *Chevalier*, 14356 (San Thomé), *Soyaux*, 444.

CONGO FREE STATE, *Burton*, *Chr. Smith*, 63, *Schweinfurth*, 3189 (Monbuttu).

ANGOLA, *Welwitsch*, 1851.

CULT. Kew Gardens.

103. M. MACROPHYLLA, *Benth. in Hook. Ic. Pl.* t. 788–9 (1848); *Hook. f. Niger Fl.* (1849) 318, t. 32–3; *Baker in Oliver, Fl. Trop. Afr.* ii. 127; *Harms in Notizbl. Bot. Gart. Berlin*, App. xxi. (1911) 68, t. ?—M. Hookeriana, *Taub. in Engl. u. Prantl, Pflanzenfam.* iii. 3, 271.

Arbor parva, 2–5 m. alta, cortice brunneo, ramis lenticellatis. *Folia* 5–6-juga, 30–60 cm. longa, petiolo 3-plo longiora, rachi mox glabra; foliola superiora lateralia ovato-oblonga, obtuse acuminata, basi obtusa, 10–20 cm. longa, chartacea, supra glabra et pallide viridia, subtus tenuiter adpresse griseo-sericea, venis marginem appropinquantibus 12–14-paribus erecto-patentibus subtus prominentibus; petioluli 5–8 mm. longi; stipellæ caducæ. *Paniculæ* racemiformes in foliorum superiorum axillis erectæ, 40–60 cm. longæ, pedunculis 3-plo longiores, rachi primo puberula; nodi floriferi 3–5 mm. longi, velutini, bracteis brevibus lanceolatis suffulti. *Flores* in nodis fasciculati, 2·4 cm. longi; pedicelli 6–9 mm. longi, ut calyces brunneo-pubescentes; bracteæ 1–2 mm. longæ, lanceolatæ. *Calyx* campanulatus, basi truncatus, 5 mm. longus, 6 mm. latus, dentibus obsoletis; bracteolæ rotundatæ, 1 mm. longæ, deciduæ. *Petala* glabra, rosea vel purpurea; vexilli lamina ovata, in unguem brevem angustata, 2·1 cm. longa, 1·8 cm. lata; alæ carinæque petala oblongæ, basi truncatæ. *Stamina* monadelpha, vexillare basi solutum. *Discus* brevis, lobulatus. *Ovarium* lineare, velutinum, multiovulatum. *Legumen* lineare, ad basin angustatum, 15 cm. longum, 2–3 cm. latum, velutinum, glabrescens, facile dehiscens, valvis tenuiter lignosis, liberis, obscure marginatis. *Semina* 3–4, oblonga, compressa; radicula brevis inclusa.

Flowers in November.

KAMERUN, *Zenker*, 3110, *Ledermann*, 6182 (Ndonge), *Bates*, 59 (Batanga).

FRENCH CONGO, *Griffon*, 693.

CULTIVATED: Fernando Po, *Vogel*, 117 (*type*).

Bentham and Hooker apparently published this species independently, but under the same name and with the same (Fitch's) plate. Many plates were prepared about 1848–9 from West African material in the Kew Herbarium for publication in the 'Icones,' and the name *M. macrophylla* was doubtless in MS. on the type specimens.

Taubert apparently thought that Bentham's and Hooker's *M. macrophylla* were different plants, and therefore distinguished the latter as *M. Hookeriana*.

104. M. MANNII, *Baker in Oliver, Fl. Trop. Afr.* ii. 127; *De Wild. in Ann. Mus. Congo*, sér. 3, i. 62, sér. 5, ii. 147; *De Wild. Etudes Fl. Bangala*, 323. —Lonchocarpus Zenkeri, *Taub. in Engl. Jahrb.* xxiii. (1896) 193.

Arbor parva, 6–8 m. alta, cortice fusco lævi lenticellato, novellis brunneo-sericeis. *Folia* 7–11-juga, 30–50 cm. longa, petiolo 3-plo longiora, rachi ut ea paniculæ fere glabra; stipulæ oblongo-lineares, 5–6 mm. longæ, reflexæ, persistentes; foliola superiora lateralia oblonga, breviter acuminata, basi obtusa, 8 cm. longa, chartacea, glabra, venis marginem appropinquantibus 8–10-paribus erecto-patentibus ob colorem solum conspicuis ; petioluli pubescentes, 4 mm. longi. *Paniculæ* racemiformes axillares, 25–40 cm. longæ ; nodi floriferi elongati, multiflori, ad 7 mm. longi. *Flores* aggregati, 2·4 cm. longi ; pedicelli 4 mm. longi ; bracteæ bracteolæque breves, obtusæ. *Calyx* campanulatus, basi apiceque truncatus, dentibus obsoletis, breviter adpresse sericeus. *Petala* glabra ; vexilli lamina rotundata, in unguem 3-plo breviorem abrupte angustata ; alæ oblongæ, basi subfalcatæ ; carinæ petala conformia, apice paullo velutina. *Stamina* monadelpha, vexillare basi solutum. *Ovarium* lineare, breviter velutinum, multiovulatum. *Legumen* lineare, 13 cm. longum, 2 cm. latum, velutinum, valvis crasse coriaceis.

FRENCH CONGO, *Mann (type)*.

KAMERUN : Bipinde, *Zenker*, 1173, 1009, *Preuss*, 258, *Zenker*, 100 (at 800 m.).

105. M. PSILOPETALA, *Harms in Wiss. Erg. Deutsch. Zentr. Afr. Exp.* 1907–8, ii. 256 (reimpr.).

Frutex elatus vel arbor parva, ramis primo velutinis sulcatis. *Folia* 2–4-juga, 15–40 cm. longa, rachi glabra vel tenuiter puberula ; stipulæ caducæ ; foliola lateralia superiora oblonga, caudata, basi rotundata, 10–11 cm. longa, papyracea, glabra, venis marginem appropinquantibus 6-paribus inter se arcuatis supra impressis infra prominentibus ; petioluli 5 mm. longi ; stipellæ caducæ. *Paniculæ* perulatæ, sessiles, ramosæ, in foliorum superiorum axillis, 13–15 cm. longa, rachi ut ramis calycibusque sericeo-pubescente ; ramuli floriferi, ad 3 mm. longi. *Flores* fasciculati, 1·4 mm. longi ; pedicelli 4 mm. longi ; bracteæ lanceolatæ, caducæ, parvæ. *Calyx* campanulatus, puberulus, 5–6 mm. longus, dentibus 5 obscuris ; bracteolæ subulatæ, 1–2 mm. longæ. *Petala* glabra, brunneo-viridula ; vexilli lamina rotundata, ecallosa, basi abrupte in unguem brevem angustata, purpurascens ; alæ carinæque petala oblongæ, hamatæ. *Stamina* diadelpha. *Ovarium* lineari-lanceolatum, in stylum angustatum, multiovulatum, pubescens.

Flowers January to April.

CONGO FREE STATE : Fort Beni, *Mildbraed*, 3209.

106. M. THONNERI, *De Wild. in Etudes Fl. Bangala*, 218, t. i.

Frutex vel arbor parva, cortice lævi. *Folia* 4-juga, circ. 20 cm. longa, rachi subglabra, petiolo 3–4-plo longiora ; stipulæ parvæ, ovatæ, persistentes ; foliola superiora lateralia obovata, breviter et obtuse acuminata, apice retusa, basi rotundata vel subcordata, 6–9 cm. longa, chartacea, glabra, venis marginem appropinquantibus 6–7-paribus infra prominulis ; petioluli 5–6 mm. longi, puberuli ; stipellæ nullæ. *Paniculæ* axillares, 30–50 cm. longi, rachi ramisque velutinis ; nodi floriferi 1–2 mm. longi. *Flores* fasciculati, 1·6 cm.

longi; pedicelli 2 mm. longi; bracteæ minutæ. *Calyx* campanulatus, apice basique truncatus, 4 mm. longus, aureo-velutinus; bracteolæ minutæ. *Petala* glabra, rubida; vexilli lamina ovata, in unguem brevem acuminata; alæ lineari-oblongæ, basi obtusæ; carinæ petala oblonga, subhamata. *Stamina* diadelpha. *Discus* brevis, annularis. *Ovarium* breviter stipitatum, lanceolatum, multiovulatum, sericeum.

Flowers in March.

CONGO FREE STATE: Mokoange (Ubangi), *Thonner*, 268 (*type*).

107. M. ABOENSIS, *Hook. f. ex Baker in Oliver, Fl. Trop. Afr.* ii. 130.—M. macrophylla, *Benth., var.* aboensis, *Hook. f. in Hook. Niger Fl.* 319.

Arbor 10–15 m. vel rarius minor, cortice rugoso griseo, novellis velutinis mox glabris. *Folia* 6–9-juga, 40–60 cm. longa, petiolo 5-plo longiora, rachi ut pagina inferiore foliolorum et ut inflorescentia tota præter petala plus minus ferruginea; stipulæ bracteæque lineares, obtusæ, curvatæ, 6 mm. longæ; foliola lateralia superiora anguste oblonga, breviter acuminata, apiculata, basi rotundata, chartacea, supra glabra, nitentia, venis marginem appropinquantibus 10–11-paribus arcuatis infra prominentibus; petioluli 5 mm. longi; stipellæ caducæ. *Paniculæ* racemiformes apice approximatæ, sæpius supra-axillares, erectæ, 20–50 cm. longæ, pedunculis 4-plo longiores; rami floriferi 1·0–1·5 cm. longi, rarius breviores. *Flores* in ramulis approximati, 2·4–2·6 cm. longi; pedicelli 5–8 mm. longi. *Calyx* brunneus, 8 mm. longus, apice basique truncatus, dentibus obsoletis. *Petala* glabra, purpurea; vexilli lamina rotundata, ecallosa, in unguem abrupte angustata; alæ carinæque petala oblongæ, subhamatæ. *Stamina* monadelpha, vexillare basi solutum. *Discus* annularis. *Ovarium* lineare, multiovulatum. *Legumen* lineare, 14 cm. longum, 2–3 cm. latum, rubro-brunneum, velutinum, obscure marginatum. *Semina* 4–5.

NIGERIA, *Ansell* (Ebo, *type*), *Barter*, 148, 1806, *Mann*, 512 (Bonny River), *Vogel* (Ebo), *H. H. Johnston* (Cross River Exp.), *Williams*, 24 (Calabar), *Holland*, 201 (Okuni), *Dennett*, 15, and *H. N. Thompson*, 5 (Benin City).

KAMERUN: Yaunde Station, *Zenker*, 317.

Var. GLABRESCENS, *Dunn*, var. nov. Omnibus partibus glabrior.

SPANISH GUINEA: Nelleburg, *Tessmann*, 412.

KAMERUN: *Zenker et Staudt*, 100 (Yaunde).

108. M. PAUCIJUGA, *Harms in Engl. Jahrb.* xxvi. (1899) 287.

Frutex? ramulis rugosis rubro-brunneis. *Folia* 2-juga, 10–12 cm. longa, rachi ut petiolulis paginaque inferiore foliolorum puberula, petiolo ter longiora; foliola superiora lateralia obovata, apice obtusa, basi rotundata, 5 cm. longa, membranacea, supra glabra, reticulata, venis 6–7-paribus utrinque inconspicuis; petioluli 3 mm. longi; stipellæ nullæ. *Paniculæ* racemiformes apice ramulorum fasciculati; nodi floriferi parvi, sessiles.

Flores 1–2-ni, 1·0–1·1 cm. longi ; pedicelli 6–7 mm. longi, ut calyces minute puberuli ; bracteæ bracteolæque nullæ vel caducæ. *Calyx* campanulatus, 3–4 mm. longus, dentibus tubo 10-plo brevioribus. *Vexilli* lamina rotundata, in unguem brevissimum angustata, basi bicallosa ; alæ carinæque petala ovatæ, basi obtusæ. *Stamina* monadelpha. *Discus* nullus. *Ovarium* lanceolatum, pubescens, multiovulatum.

German East Africa (probably) : Salanda, *Fischer*, 194 (*type*).

109. M. Thonningii, *Baker in Oliver, Fl. Trop. Afr.* ii. 128 (syn. exclus.); *De Wild. in Ann. Mus. Congo*, sér. 3, i. 62 ; *Stapf in Johnston, Liberia*, ii. 593.—M. Atite, *Harms in Engl. Jahrb.* xxxiii. (1902) 167. Robinia Thonningii, *Schum. et Thonn. Pl. Guin.* 349.

Arbor mediocris, 6–10 m. alta, præter inflorescentiam et costam foliolorum glabra, cortice pallido rugoso. *Folia* (3–)4-juga, 15–20 cm. longa, petiolo 5–6-plo longiora ; stipulæ oblongæ, caducæ ; folia lateralia superiora lanceolata vel ovato-oblonga, obtuse acuminata, apiculata, basi obtusa, 5–6 cm. longa, chartacea, tandem reticulata, venis marginem approximantibus 5–7-paribus arcuatis infra prominulis, costa basi subtus utrinque setulosa ; petioluli 4–5 mm. longi ; stipellæ nullæ. *Racemi* (rarissime paniculæ racemiformes) præcoces, axillares, 12–22 cm. longi, ad basin sæpius nodiferi sed solum in partibus tres superioribus floriferi, rachi pubescenti ; nodi floriferi sæpissime sessiles, uniflori. *Flores* approximati, 1·5–1·8 cm. longi ; bracteæ oblongæ, caducæ ; pedicelli 6–7 mm. longi, paullo supra medium bibracteolati, ut calyces bracteolæque setaceæ 1 mm. longæ adpresse sericei. *Calyx* campanulatus, 6–7 mm. longus, dentibus tubo 8-plo brevioribus. *Petala* lilacina vel rarius alba ; vexilli lamina rotundata, in unguem 4-plo breviorem subito contracta, leviter bicallosa, medio basi et dorso ut unguis tenuiter hirtula ; alæ carinæque petala oblongæ, basi obtusæ, præcipue inferius hirtulæ. *Stamina* monadelpha, vexillare basi solutum. *Discus* breviter annularis. *Ovarium* lineare, sericeum, multiovulatum. *Legumen* lineare, ad 16 cm. longum, 2 cm. latum, suturis immaturis incrassatis, glabrum, nitens, dehiscens ; valvæ lignosæ, inter semina cohærentes. *Semina* 4–6, oblonga, lenticularia.

Flowers from August to March, fruits in the following December.

Sierra Leone, *Irving* (Abbeokuta, "Indigo").

Gold Coast, *W. H. Johnson*, 456, 911 (Krobo Plains).

Dahomey : Cercle d'Abomey, *Chevalier*, 23271 (entre Massi et Goutyssa), Moyen-Dahomey, Cercle de Sabalon, *Chevalier*, 23730 (entre Gonka et Banté).

Togo, *Warnecke*, 66, *Baumann*, 128 (Misahöhe).

Nigeria : Old Calabar, *Robb* ; Lagos, *Foster*, 21, *MacGregor*, 216, *Rowland* ; N. Nigeria, *Dalziel*, 404, 23, *Elliott*, 36, 37, *Parsons* (Zario) ; S. Nigeria, *Unwin*, 24, *Barter*, 481, 1618, 1624.

ANGOLA (cultivated), *Gossweiler*, 491 (Loanda) ; St. Thomé, *Quintas*, 113.

As a shade-tree in towns and villages it is commonly cultivated throughout and beyond its natural range. Mr. Gossweiler tells me that in Angola it is a favourite tree for forming avenues along new roads, on account of its beauty during flowering-time and the ease with which it can be propagated. Large branches up to 3 inches thick, severed from the trees and planted in the ground, will root and be in leaf again in a month or two. Baker in revising the Millettias for the 'Flora of Tropical Africa,' did not distinguish Baillon's *M. Griffoniana* from *Robinia Thonningii*, and, as the abundant material now available proves the former to be a *Lonchocarpus*, his synonymy and geographical distribution have to be restricted. An unfailing mark of distinction of *M. Thonningii* from all allied species is the small brush of hairs at the base of the midrib below its otherwise glabrous leaflets.

110. M. SANAGANA, *Harms in Engl. Jahrb.* xxvi. (1899) 288.

Arbor parva, cortice hornotino tenuiter velutino lenticellato. *Folia* 4-(3–5-)juga, 30–40 cm. longa, rachi tereti striata mox glabra ; stipulæ caducæ ; foliola superiora lateralia oblonga vel lanceolato-oblonga, apice acuminata, caudata, basi obtusa, 10–15(–25) cm. longa, papyracea, glabra, venis marginem appropinquantibus 7–9-paribus haud prominentibus ; petioluli 4–5 mm. longi ; stipellæ nullæ. *Paniculæ* racemiformes, ab apice ramorum plures, 25–35 cm. longæ, rachi brevissime velutina ; nodi floriferi globulares, 2 mm. longi. *Flores* fasciculati, 1·8–2·0 cm. longi. *Calyx* apice basique truncatus, dentibus obsoletis, sericeus. *Vexilli* lamina rotundata, basi truncata, dorso dense sericea, ungue 4–5-plo longior ; alæ ovatæ, basi in unguem æquilongum obtuse contractæ ; carinæ petala conformia, basi autem subhamata. *Stamina* monadelpha, vexillare basi solutum. *Discus* annularis. *Ovarium* lineare, sericeum, multiovulatum. *Legumen* lineare, 13 cm. longum, 3 cm. latum, dehiscens ; valvæ elasticæ, glabræ, inter semina primo cohærentes, commissura acuta. *Semina* 4, 1·5 cm. longa et lata, nitentia, castanea.

Flowers in February, fruits in March.

SIERRA LEONE : Yelisanda, *Smythe*, 66 ; Kambia, *Scott Elliot*, 5225 *b* ; Kofiu, Scarcies, *Scott Elliot*, 4598.

FRENCH GUINEA, *Chevalier*, 12053, 12165, 12737 (Conaky), 13091 (Vallée de la Santa).

KAMERUN, *Zenker*, 1466 (*type*), 2449 ; Fernando Po, *Barter*, 1597.

Closely resembles *Lonchocarpus sericeus*, H. B. K., but is distinguished by its fruit.

111. M. Zechiana, *Harms in Engl. Jahrb.* xl. (1907) 36.

Arbor magna, præter inflorescentiam glabra, cortice lenticellato. *Folia* 6–8-juga, 20–60 cm. longa, petiolo 5-plo longiora; stipulæ caducæ; foliola superiora lateralia lanceolato-oblonga, acuminata, basi obtusa, 6–15 cm. longa, chartacea, supra nitentia, venis marginem approximantibus 6–8-paribus erecto-patentibus infra prominentibus; petioluli 3 mm. longi; stipellæ minimæ vel nullæ. *Paniculæ* racemiformes in paniculam terminalem basi paullo foliosam collectæ, et apice ramorum aggregatæ, 15–25 cm. longæ, rachi ut ramulis pedicellis calycibus dorsoque vexilli breviter dense sericeo-velutina; ramuli floriferi ad 1·1 cm. longi, rare longiores, basi breviter nudi. *Flores* aggregati, 2·5–2·8 cm. longi; pedicelli 3–5 mm. longi; bracteæ non visæ; bracteolæ 1 mm. longæ, deciduæ. *Calyx* 7–8 mm. longus, apice basique truncatus, dentibus tubo 8-plo brevioribus. *Vexilli* lamina rotundata, basi truncata, ungue bis longior, dorso pulchre brunneo-sericea, ecallosa; alæ oblongæ, hamatæ; carinæ petala oblonga, hamata, apice paullo hirtula. *Stamina* monadelpha, vexillare basi solutum. *Discus* breviter tubularis vel annularis. *Ovarium* lineare, sericeum, multiovulatum. *Legumen* lineare, ad 14 cm. longum, 1·5–2·5 cm. latum, glabrum, facile dehiscens, valvis coriaceis. *Semina* ad 8, discoidea, 1·4 cm. longa et lata.

Sierra Leone, *Smythe*, 127.

Liberia, *Dinklage*, 2632 (Webbo-am-Cavally).

Ivory Coast: Moyenne Sassandra, *Chevalier*, 19142; Grabo, *Chevalier*, 19740; Endé, *Chevalier*, 22473.

Togo, *Busse*, 3449 (Vedeme, *type*).

Nigeria: Oban, *Talbot*.

Gold Coast: Aburi Hills, *W. H. Johnson*, 464.

112. M. Stapfiana, *Dunn*, sp. n.

Frutex 3–4 m. altus, præter inflorescentiam glaber, cortice lenticellato. *Folia* 4-juga, 20–30 cm. longa, petiolo 5-plo longiora; stipulæ oblongæ, 3 mm. longæ, deciduæ; foliola superiora lateralia 8–10 cm. longa, acuminata, basi obtusa, chartacea, supra nitentia, venis marginem approximantibus 7–8-paribus erecto-patentibus infra prominentibus; petioluli 3 mm. longi; stipellæ nullæ. *Paniculæ* racemiformes in summis ramis aphyllis aggregatæ, 10–15 cm. longæ, rachi superius ut pedicellis calycibus dorsoque vexilli dense breviter adpresse sericea; nodi floriferi ad 4 mm. longi. *Flores* fasciculati, 2·1–2·4 cm. longi; pedicelli 3–4 mm. longi; bracteæ nullæ. *Calyx* campanulatus, basi truncatus, dentibus tubo 6-plo brevioribus; bracteolæ minutæ, persistentes, lanceolatæ. *Vexilli* lamina rotundata, in unguem brevem subito contracta, ecallosa; alæ carinæque petala oblongæ, hamatæ. *Stamina* monadelpha, vexillare basi solutum. *Discus* annularis. *Ovarium* lineare, sericeum, multiovulatum.

Kamerun, *Mann*, 2216 (Cameroon River).

This fine species is dedicated to my friend Dr. Otto Stapf, the distinguished Keeper of Kew Herbarium, to whose kindness I owe many of the advantages which I have enjoyed in revising this genus.

113. M. NUDIFLORA, *Welw. ex Baker in Oliver, Fl. Trop. Afr.* ii. 130; *Hiern, Cat. Welw. Afr. Pl.* i. 228; *Ficalho, Pl. Uteis Afr. Portug.* 132.

Arbor at 13 m. alta, ramis tuberculatis, ramulis pendulis mox glabris. *Folia* 4-juga, 15–25 cm. longa, petiolo 5-plo longiora, rachi laxe ferruginea; stipulæ caducæ; foliola lateralia superiora oblongo-lanceolata, breviter acuminata, basi cuneata, 6–8 cm. longa, molliter coriacea, fere carnosa (*Welw.*), supra atro-viridia, subtus breviter tomentosa, venis marginem appropinquantibus 7–9-paribus erecto-patulis haud prominentibus; petioluli 4–6 mm. longi; stipellæ nullæ. *Racemi* præcoces, ad 30 cm. longi, breviter pedunculati; raches pedicelli calycesque laxe ferruginei; nodi floriferi parvi, sessiles, pauciflori. *Flores* fasciculati, præcoces, 2 cm. longi; pedicelli 3 mm. longi; bracteæ deciduæ, bracteolæque paullo subtus calycem affixæ, setaceæ, 2–3 mm. longæ. *Calyx* 9 mm. longus, basi atro-brunneus cæteroquin rubro-brunneus, dentibus angustis acuminatis tubo bis brevioribus setuliferis. *Petala* pulchre purpureo-violacea; vexilli lamina ovata, in unguem 4-plo breviorem abrupte contracta, dorso tenuiter sed facie in medio basis densius pubescens; alæ anguste oblongæ, basi truncatæ setulosæ; carinæ petala oblonga, basi cuneata, in parte inferiore ungueque hirtula. *Stamina* monadelpha, vexillare basi solutum. *Discus* nullus. *Ovarium* lineare, pubescens, 7–10-ovulatum. *Legumen* pendulum.

Flowers, which appear before the leaves and cover the whole tree, in July and August, nearly ripe fruit in August.

ANGOLA, *Welwitsch*, 1850 (primitive forests of Quibanga about Sange and on the left bank of the River Cuango: *type*).

Described by Welwitsch as "a vast and beautiful tree," leafless at time of flowering.

114. M. PALLENS, *Stapf in Johnston, Liberia*, ii. 593.

Frutex cortice fusco lenticellato, præter inflorescentiam glaber. *Folia* 6-juga, ad 30 cm. longa, petiolo 6-plo longiora; stipulæ caducæ; foliola lateralia superiora ovato-oblonga vel oblonga, acuminata, sæpe fere caudata, basi oblique obtusa, 6–12 cm. longa, papyracea, utrinque tenuiter reticulata, venis marginem approximantibus 5–7-paribus arcuatis; petioluli 2–4 mm. longi; stipellæ setaceæ, 1–2 mm. longæ. *Paniculæ* racemiformes, axillares, 15–20 cm. longæ, dimidio inferiore vel plure nudo, rachi superiore pubescente; nodi floriferi ad 4 mm. longi. *Flores* 1–4-ni, 2 cm. longi; pedicelli 3–4 mm. longi; bracteæ minutæ. *Calyx* 5–6 mm. longus, dentibus tubo 6-plo brevioribus, laxe adpresse sericeus, basi bibracteolatus; bracteolæ minutæ.

Petala rubida vel purpurea, exodorata; vexilli lamina ovata, in unguem brevem angustata, dorso tenuiter adpresse sericea; alæ oblongæ, basi hamatæ; carinæ petala subhamata. *Stamina* monadelpha, vexillare basi solutum. *Discus* breviter tubulosus. *Ovarium* pubescens, lineare, multiovulatum. *Legumen* lineare, 7 cm. longum, 1·8 cm. latum, suturis incrassatis, subglabrum. *Semina* 3.

Flowers January to March.

French Guinea, *Chevalier*, 12637 (Timbo), *Farmar*, 259, *Heudelot*, 793.

Sierra Leone, *Scott Elliot*, 4609, 5771, 5839, *H. H. Johnston*, 68 (Free Town), *Sierra Leone Herb.* 7 (Furca).

Liberia, *Whyte* (within 6 miles of Munrovia, *type*), *Dinklage*, 1787, 1962, 1994.

115. M. Conraui, *Harms in Engl. Jahrb.* xxxiii. (1902) 168.

Arbor parva, cortice brunneo lenticellato. *Folia* 5–6-juga, 22–28 cm. longa, omnino glabra, nigrescentia; stipulæ caducæ; foliola lateralia superiora oblonga, caudata, 5–10 cm. longa, chartacea, venis marginem appropinquantibus 7–9-paribus supra et subtus paullo prominulis; petioluli 4 mm. longi; stipellæ breves, setaceæ. *Paniculæ* racemiformes ad ramorum apices fasciculatæ, 10–20 cm. longæ, pedunculatæ, rachi ut pedicellis calycibusque breviter aureo-velutina; nodi floriferi globosi vel breviter clavati. *Flores* fasciculati, 1·7–1·9 cm. longi; pedicelli 5 mm. longi. *Calyx* campanulatus, 7 mm. longus et latus, dentibus 3–5-plo tubo brevioribus. *Petala* pallide violacea; vexilli lamina late ovata, reflexa, basi truncata, bicarinata, extus dense sericea, ungue paullo longior; alæ fortiter hamatæ; carinæ petala in unguem angustata. *Stamina* monadelpha. *Discus* obsoletus. *Ovarium* lineare, sericeum.

Flowers in February.

Var. typica. Calycis dentibus tubo 5-plo brevioribus rotundatis.

Kamerun, *Conrau*, 71 (Bangwe, *type*).

Var. Ledermannii, *Dunn*, var. nov. Calycis dentibus tubo 3-plo brevioribus, triangularibus.

Kamerun, *Ledermann*, 2754 (Tchape Pass).

116. M. Sereti, *De Wild. in Ann. Mus. Congo*, sér. 5, iii. 204.

Arbor ligno durissimo, præter inflorescentiam glabra, ramulis lævibus paullo lenticellatis. *Folia* 8-juga, 30–40 cm. longa, petiolis 7-plo longiora; stipulæ parvæ, oblongæ, persistentes; foliola superiora lateralia oblonga, subito acuminata, caudata, basi obtusa, 10–12 cm. longa, papyracea, utrinque reticulata, venis marginem propinquantibus 9-paribus parum prominentibus; petioluli 4 mm. longi; stipellæ setaceæ, 2 mm. longæ. *Paniculæ* racemiformes axillares, 15–25 cm. longi, parte florifera duplo longiore quam sterili; rachis apice puberula; nodi floriferi 1–3 mm. longi; bracteis parvis setaceis. *Flores* fasciculati, 1·8 cm. longi; pedicelli 3–4 mm. longi; bracteæ nullæ. *Calyx* late campanulatus, 4 mm. longus, 3·5 mm. latus, breviter aureo-sericeus, dentibus brevibus; bracteolæ oblongæ, 1 mm. longæ. *Vexilli* lamina alba, rotundata, in unguem abrupte angustata, dorso breviter dense sericea; alæ carinæque petala miniaria, albo-maculata, oblonga, uncinata. *Stamina* monadelpha, vexillare basi solutum. *Discus* tubularis. *Ovarium* lineare, sericeum, multiovulatum.

CONGO FREE STATE, *Seret*, 793 (Gagara, *type*).

117. M. DRASTICA, *Welw. ex Baker in Oliver, Fl. Trop. Afr.* ii. 128; *De Wild. in Ann. Mus. Congo*, sér. 3, i. 61, sér. 4, 193; *De Wild. in Compagnie de Kasai*, 310; *De Wild. Études Fl. Bangala*, 218; *Hiern, Cat. Welw. Afr. Pl.* i. 226; *Ficalho, Pl. Ut. Afr. Portug.* 132.

Frutex vel *arbor* 2–30 m. alta, cortice fusco lenticellato. *Folia* 8–10-juga, 25–35 cm. longa, petiolo 10-plo longiora, rachi canaliculato paullo rufo-pubescente; stipulæ oblongæ, 4–5 mm. longæ, persistentes; foliola lateralia superiora oblanceolato-oblonga, acuminata, basi obliqua, obtusa, 5–8 cm. longa, chartacea, supra glabra, subtus, præter venas plus minus sericeo-pubescentes, glabra, glauca, venis marginem approximantibus 6–8-paribus porrectis utrinque obscuris; petioluli 3 mm. longi; stipellæ setaceæ, 1–1·5 mm. longæ. *Paniculæ* racemiformes axillares, et in summo caule fasciculati, 15–20 cm. longi, pedunculo brevi, rachi robusta breviter velutina; nodi floriferi globulares, sessiles vel subsessiles, 1–3 mm. longi. *Flores* in nodo quoque pauci, fasciculati, 1·6–1·8 cm. longi; pedicelli 3 mm. longi; bracteæ caducæ. *Calyx* dense brunneo-velutinus, campanulatus, 5 mm. longus, dentibus tubo 7-plo brevioribus, inferiori paullo cæteris longiore. *Petala* violacea; vexilli lamina ovata, in unguem brevem angustata, dorso brunnea adpresse sericea; alæ oblongæ, uncinatæ; carinæ petala subhamata. *Stamina* monadelpha, vexillare basi solutum. *Discus* annularis. *Ovarium* pubescens, lineare, multiovulatum. *Legumen* immaturum lineare, 17 cm. longum, 2 cm. latum, suturis incrassatis, glabrum.

Flowers in January and February.

KAMERUN, *Ledermann*, 2070 and 2082 (Ngom), 2572 (Mba), *Zenker*, 670, 711 (Jaunde Station).

FRENCH CONGO, *Tessmann*, 834, *Soyaux*, 57 (Loango).

CONGO FREE STATE, *Schweinfurth*, 3470 (Monbuttu), *Chr. Smith*, 60, *Mildbraed*, 2355 (Fort Beni), 2466 (Lumengo), *Marques*, 33 (Malange).

ANGOLA, *Welwitsch*, 1856–8 (*types*).

Welwitsch describes *M. drastica* as a tree with strong wood used for making charcoal. It has an ample crown and the habit of an Ash. In Angola it is called *Ditenda* or *Quitenda*.

118. M. BREVISTIPELLATA, *De Wild. in Ann. Mus. Congo*, sér. 4, 193.

Arbor ramulis velutinis lenticellatis. *Folia* 7-juga, 20 cm. longa, rachi hirtella; foliola superiora lateralia oblongo-lanceolata, acuminata, basi cuneata, 5–7 cm. longa, utrinque tenuiter hirsuta præcipue in venis infra; stipellæ setaceæ, 1 mm. longæ. *Paniculæ* racemiformes axillares, foliis brevioribus, rachi ferrugineo-hirsuta; ramuli floriferi breves, apice multiflori. *Flores* 2·2 cm. longi; pedicelli ferruginei, 5 mm. longi; bracteolæ minutæ. *Calyx* 5 mm. longus, sparse ferrugineus, ciliatus, dentibus inconspicuis. *Vexilli* lamina suborbicularis, dorso sericea. *Stamina* monadelpha, vexillare basi solutum. *Ovarium* pubescens.

Flowers in August.

CONGO FREE STATE: Lukafu, *Verdick*, 55 (*type*).

Native name *Solemosji*.

119. M. CYANANTHA, *Dunn*, sp. n.

Frutex cortice lenticellato. *Folia* 7–8-juga, 25–35 cm. longa, petiolo decies longiora, rachi sulcata subglabra; stipulæ deciduæ; foliola lateralia superiora anguste oblonga, acuminata, basi obtusa, 9–11 cm. longa, papyracea, supra glabra, nitentia, subtus, præcipue in venis, breviter ferruginea, venis marginem appropinquantibus 6–8-paribus arcuatis supra impressis infra prominulis; petioluli 5–6 mm. longi. *Paniculæ* racemiformes plures, in summo caule fasciculatæ, 8–10 cm. longæ, sessiles, rachi ut pedicellis rufo-velutina; nodi floriferi sessiles, lati. *Flores* fasciculati, 2·7 cm. longi, pedicelli 7–8 mm. longi; bracteæ obscuræ. *Calyx* campanulatus, 8 mm. longus, 5–6 mm. latus, breviter et tenuiter ferrugineus, margine tomentosus, dentibus 4 latis tubo 7–8-plo brevioribus, superiore emarginato; bracteolæ minutæ, deciduæ. *Petala* cyanea; vexilli lamina subrotundata, in unguem gradatim angustata, ecallosa, dorso laxe sericea; alæ et carinæ petala paullo hamatæ. *Stamina* monadelpha, vexillare basi solutum. *Ovarium* lineare, dense sericeum, pluriovulatum, in stylum glabrum complanatum exiens.

Flowers in June.

UGANDA, *Bagshawe*, 357 (bank of the Kagera near Chulema).

120. M. FERRUGINEA, *Hochst. in Flora*, xxix. (1846) 597; *Baker in Oliver, Fl. Trop. Afr.* ii. 130; *Fiori, Boschi e Piante Legnose Eritrea*, 186.—Sesbania ferruginea, *Hochst. in Schimper, Herb. Abyss.* n. 279. Berrebera ferruginea, *Hochst. in Flora*, xxix. (1846) 597. Inga byrsinocarpa, *Hochst. in Schimper, Herb. Abyss.* n. 536.

Arbor parva, cortice mox glabra nitente. *Folia* 10–11-juga, 23–26 cm. longa, pedunculo 6-plo longiora, rachi ut pagina inferiore foliolorum ad maturitatem velutina tarde glabrescente tandem omnino glabra glauca; stipulæ lineares, laxæ, 4 mm. longæ; foliola lateralia superiora anguste lanceolata, oblonga, gradatim acuminata, basi rotundata, obtusa, 5–7 cm. longa, chartacea, supra glabra, venis marginem appropinquantibus 8–10-paribus erecto-patentibus infra prominulis; petioluli 1·5–2 mm. longi; stipellæ setaceæ, persistentes, 1 mm. longæ. *Paniculæ* racemiformes in caule summo axillares, 20–30 cm. longæ, in dimidio inferiore nudæ, rachi ferrugineo-velutina; nodi floriferi globulares vel ovales vel cylindrici, cum pedunculo brevi 3–8 mm. longi, 3 mm. lati. *Flores* 2–4-ni fasciculati, 2·1–2·3 cm. longi; pedicelli 3·5–4·5 mm. longi, ut calyx vexillique dorsum adpresse dense sericei. *Calyx* 8 mm. longus, dentibus tubo 8-plo brevioribus; bracteolæ minutæ, ·5 mm. longæ. *Vexilli* lamina rotundata, basi truncata, ecallosa, in unguem 7-plo breviorem abrupte contracta; alæ carinæque petala oblongæ, basi truncatæ vel subhamatæ, breviter unguiculatæ. *Stamina* monadelpha, vexillare basi solutum. *Discus* breviter tubulosus. *Ovarium* lineare, sericeum, multiovulatum. *Legumen* lineare, 18–27 cm. longum, 2·5–3 cm. latum, glabrum, suturis paullo incrassatis.

Flowers in December, fruit in June.

ABYSSINIA, *Schimper*, 279, 861 (Abba Gerima, *types*), *Salt*.

SOUDAN, *Heudner*, 80.

GALLALAND, *Ellenbeck*, 1725 (Sidamo).

ERITREA (fide *Fiore*, *l. c.*).

Herbarium specimens gathered at different seasons have strikingly different facies owing to the change in hairiness of the leaflets. In June, when the flowers are in bud and the fruit ripe, the leaflets are softly velvety beneath, but they become quite glabrous and glaucous beneath by the time the flowers are expanded in December.

120 *a*. M. AROMATICA, *Dunn*, sp. n.—M. rhodantha, *Hiern. Cat. Welw. Afr. Pl.* i. 229; *Ficalho, Pl. Uteis Afr. Portug.* 133, non *Baill.*

Arbor 4–9 m. alta; lignum flavescens, aromaticum; ramuli rugosi, mox glabri. *Folia* 9–10-juga, 25–27 cm. longa, petiolo 7-plo longiora; rachis laxe ferruginea; stipulæ lanceolatæ, 4 mm. longæ, caducæ; foliola superiora lateralia lanceolato-oblonga, apice breviter obtuse acuminata, nonnunquam retusa, 5–6 cm. longa, papyracea, glaucescentia, præter costam subtus dense ferrugineam tandem utrinque subglabra; venæ marginem appropinquantes 6–8-pares in nervum marginalem currentes, utrinque paullo reticulatæ; petioluli 2 mm. longi; stipellæ setaceæ, 3 mm. longæ, persistentes. *Paniculæ* racemiformes axillares, 14·5 cm. longæ (una tantum visa); ramuli floriferi versus apicem floriferi, 3–4 mm. longi, ut rachis ferruginei. *Flores* fasciculati, 1·2 cm. longi; pedicelli 3–4 mm. longi; bracteæ bracteolæque lanceolatæ, 1 mm. longæ. *Calyx* campanulatus, laxe pubescens, 3 mm. longus; dentes tubo 6–8-plo breviores, acuminati. *Petala* violacea; vexilli lamina rotundata in unguem brevem angustata, basi ecallosa, dorso adpresse sericea; alæ carinæque petala oblonga, basi obtusæ. *Stamina* monadelpha, vexillare basi solutum. *Ovarium* pubescens, lineare, pluriovulatum. *Legumen* immaturum lineare.

Flowers in January.

ANGOLA : District Pungo Andongo, *Welwitsch*, 1853 (wooded or bushy slopes near Caghuy) ; District of Golungo Alto, 1852 (banks of Mata de Quisucula).

The tree is called *Quisecua* by the natives, who highly value its aromatic wood.

121. M. DURA, *Dunn in Journ. Bot.* xlix. (1911) 221.—M. ferruginea, *Harms in Wiss. Erg. Deutsch. Zentr. Afr. Exp.* 1907–8, ii. 256, non *Hochst.*

Arbor vel *frutex* 2–12 m. alta, gracilis vel scandens, cortice olivaceo lenticellato primo ferrugineo mox glabro. *Folia* 8–9-juga, 25–35 cm. longa, petiolo 5–6-plo longiora, rachi ut pagina inferiore foliolorum primo laxe ferruginea mox præter costa glabra ; stipulæ tarde deciduæ, lineares, obtusæ, 5–7 mm. longæ; foliola lateralia superiora anguste oblanceolato-oblonga, gradatim acuminata, basi rotundata, 6–9 cm. longa, chartacea, venis marginem approximantibus 8-paribus erecto-patentibus infra prominulis ; petioluli 3·5–4·5 mm. longi ; stipellæ setaceæ, 1·5–2 mm. longæ. *Paniculæ* racemiformes in caule summo axillares, 20–25 cm. longæ, in partibus tribus superioribus vel paullo majus floriferæ, rachi ut pedicellis calyceque breviter laxeque ferruginea ; nodi floriferi sessiles. *Flores* 2–4-ni, fasciculati, 2·5–2·7 cm. longi ; pedicelli 1·0–1·3 cm. longi. *Calyx* campanulatus, 6–8 mm. longus, dentibus tubo 6-plo brevioribus ; bracteolæ parvæ, paullo infra calycem affixæ. *Petala* pulchre roseo-violacea ; vexilli lamina rotundata, basi cordata, medio rugosa, in unguem angustata ; alæ basi truncatæ, carinæ petala subhamata. *Stamina* monadelpha, vexillare basi solutum. *Discus* calyci adnatus. *Ovarium* pubescens, lineare, multiovulatum. *Legumen* lineare, 12 cm. longum, 2 cm. latum, suturis haud incrassatis, dehiscens, valvis inter semina cohærentibus. *Semina* 1·2 cm. longa, ovati-lenticularia ; radicula in commissura basis truncatæ cotyledonum accumbens.

CONGO FREE STATE : Ruwenzori, *Mildbraed*, 2479.

UGANDA, *Dawe*, 452, 459, 481, *Scott Elliot*, 7544 (Ruwenzori), *Tufnell*, *Bagshawe*, 1071 (near Mpanga, River Toro).

GERMAN EAST AFRICA : Ruanda, *Kandt*, 112 (Berg Niansa).

CULTIVATED : Kew.

122. M. OBLATA, *Dunn, l. c.* 221.—M. ferruginea, *Taub. in Engl. Pflanzenw. Ost-Afr.* C, 212, non *Hochst.*

Arbor ad 30 m. alta, ramulis rugosis brunneis paullo ferrugineis. *Folia* pallida, 8–10-juga, 20–45 cm. longa, breviter petiolata, rachi laxe ferruginea glabrescente ; stipulæ oblongæ, 1 cm. longæ, persistentes ; foliola superiora lateralia lanceolato-oblonga, apice angustata, acuta vel acuminata, basi rotundata, 6–13 cm. longa, chartacea, supra glabra, subtus sparse hirsuta, venis molliter ferruginea, glabrescentia, venis marginem appropinquantibus 7–9-paribus infra prominentibus supra tandem impressis ; petioluli 3–4 mm. longi ; stipellæ setaceæ, 2–3 mm. longæ, tarde deciduæ. *Paniculæ* racemiformes, axillares, 15–35 cm. longæ, pedunculatæ, rachi laxe ferruginea ; nodi floriferi sessiles vel nonnunquam breviter pedunculati. *Flores* fasciculati, 1·7–2·2 cm. longi ; pedicelli 0·6–1·0 cm. longi, apice vel in parte superiore bibracteolati ; bracteolæ lanceolatæ, 2 mm. longæ. *Calyx* late campanulatus, 5–7 mm. longus, tenuiter laxe ferrugineus, dentibus tubo 5-plo brevioribus. *Petala* lilacina ; vexilli lamina oblata, tertia parte latior quam longa, basi ecallosa, in unguem paullo breviorem abrupte vel subcordate contracta, dorso pubescens ; alæ carinæque petala oblongæ, hamatæ. *Stamina* monadelpha, vexillare basi solutum. *Discus* nullus. *Ovarium* lineare, præter apicem stylumque complanatum adpresse sericeum, multiovulatum. *Legumen* lineare, 12 cm. longum, 2·5 cm. latum, 3–4-spermum, valvis tenuiter lignosis elasticis glabris.

Flowers from October to January, fruits ripe in December.

GERMAN EAST AFRICA, *Goetze*, 1309 (Upper Kondeland), *Buchwald*, 79 and 144 (Usambara), *Zimmermann*, 1113 *a* and 2194 (Amani), *Warnecke*, 46, *Scheffler*, 212 (Derema, Usambara), *Eick*, 166 (Kwa, Usambara), *Braun*, 1544, *Holz*, 183 (Kyimbila), *Holst*, 620 (Usambara), *Stuhlmann*, 1625 (Bach Kanjawani), *Inst. Amani*, 1662 *a*, 1486, 2292 (Mkala).

Var. PARVIFLORA, *Dunn*. Flores 1·1 mm. longi ; pedicelli calyce breviores.

GERMAN EAST AFRICA, *Stuhlmann*, 8833 and 9285 (Uluguru).

A very variable tree both in height, size of leaves and flowers, and in length of pedicel. Like *M. ferruginea*, the deciduous pubescence of its leaves changes its appearance as the season advances. Its flowers appear with the young leaves. It appears to range over the whole of German East Africa from Amani to Kondeland, especially the mountainous portions, in which it reaches an altitude of 1300 m.

123. M. USARAMENSIS, *Taub. in Engl. Pflanzenwelt Ost-Afr.* C, 212.

Arbor? ramulis gracilibus mox glabris, cortice pallide ochroleuco lenticellato. *Folia* 4–8-juga, 15–20 cm. longa, petiolo 6-plo longiora, rachi glabra canaliculata ; stipulæ caducæ ; foliola lateralia superiora, sæpius lanceolato-oblonga, paullo obtuse acuminata, apice sæpe retusa, apiculata, basi rotundata, obliqua, 3·5–5·5 cm. longa, tenuiter papyracea, sæpius subglabra, nonnunquam autem griseo-puberula, venis marginem appropinquantibus 6–7-paribus paullo reticulatis ; petioluli 2 mm. longi ; stipellæ 1 mm. longæ, setaceæ, persistentes. *Paniculæ* racemiformes axillares, ad 20 cm. longæ, pedunculis 4–5-plo longiores, rachi fere glabra ; nodi floriferi brevissimi, sessiles vel rare pedunculati, puberuli. *Flores* in nodis fasciculati, 2–3-ni, 1·5 cm. longi; pedicelli 0·8–1·0 cm. longi, ut calyces glabri; bracteæ minutæ; bracteolæ setaceæ, 1 mm. longæ, infra calycem affixæ. *Calyx* 4 mm. longus, dentibus præter inferiorem paullo longiorem tubo 6-plo brevioribus. *Petala* violacea; vexilli lamina rotundata, basi ecallosa, truncata, in unguem 4-plo breviorem contracta, dorso breviter adpresse sericea; alæ anguste oblongæ et carinæ petala ovata subfalcatæ. *Stamina* monadelpha. *Discus* nullus. *Ovarium* lineari, pubescens, multiovulatum. *Legumen* parvum, lineare, ad 5 cm. longum, 1 cm. latum, primo albo-sericea, tum tomentosa et tandem glabra.

BRITISH EAST AFRICA: Tana River, *Battiscombe*, 26.

GERMAN EAST AFRICA: *Stuhlmann*, 6358 and 7044 (Usaramo, *types*), 7456 (Dar-es-Salaam), 1039, *Busse*, 2851, *Holtz*, 1004 (Maneramango), 987, *Kirk* (Kilwa), *Wangenheim*, 8 (Tanganyika), *Holst*, 2948 (Usambara).

BRITISH CENTRAL AFRICA: Nyika Country, *Wakefield*.

PORTUGUESE EAST AFRICA: *Swynnerton*, 1425, 1474 (Chironda), *Dawe*, 513 (Mozambique), 446 (Madanda).

Var. PARVIFOLIA, *Dunn*, var. nov. Foliolis minoribus, 2–3 cm. longis.

GERMAN EAST AFRICA, *Stuhlmann*, *Perrot* (Lindi).

A species which presents rather different facies at different seasons.

124. M. ERIOCARPA, *Dunn*, sp. n.

Arbor 8 m. alta, cortice vivente viridula lævi, ramulis siccitate brunneis rugosis. *Folia* 8-juga, 15–18 cm. longa, breviter petiolata, rachi ferruginea; stipulæ oblongæ, caducæ; foliola lateralia superiora lineari-lanceolata, ad apicem obtusam mucronatam angustata, basi rotundata, 4–7 cm. longa, chartacea, supra præter venas glabra, subtus præcipue in venis laxe ferruginea, venis supra paullo impressis subtus prominentibus utrinque 4–7; petioluli 1–2 mm. longi; stipellæ 1 mm. longæ. *Paniculæ* axillares, parvæ, ramis brevioribus paucifloris. *Ovarium* 5–6-ovulatum. *Legumen* lineari-oblongum, 8–11 cm. longum, dense molliter luteo-velutinum, valvis crassis elasticis inter semina 3–4 cohærentibus; pedicelli ad 1 cm. longi. *Semina* castanea, lenticularia, 8 mm. diam.

GERMAN EAST AFRICA: Noto Plateau, nr. village of Noto, *Busse*, 2920 (at 500 m.); Mt. Uluguru, *Goetze*, 207.

125. M. LEPTOCARPA, *Dunn in Journ. Bot.* xlix. (1911) 221.

Arbor? ramulis brunneis rugosis. *Folia* 7–8-juga, breviter petiolata, 12–16 cm. longa, rachi ut foliolis laxe ferruginea glabrescente; stipulæ caducæ; foliola superiora lateralia ovato-oblonga, acuminata, basi rotundata 3–4 cm. longa, papyracea, præter venis paullo ferrugineis maturitate glabra, venis 7–9-paribus inconspicuis; petioluli 3 mm. longi; stipellæ setaceæ, 1 mm. longæ. *Paniculæ* racemiformes axillares, 13 cm. longæ, 4–5 cm. in anthesi plena latæ, pedunculati, rachi ut pedicellis laxe ferruginea; nodi floriferi sessiles vel rarius breviter pedunculati. *Flores* fasciculati, 1·7–1·8 cm. longi; pedicelli 4–5 mm. longi, apice bibracteolati; bracteæ minutæ, subulatæ; bracteolæ lanceolatæ, 5 mm. longæ. *Calyx* campanulatus, basi truncatus, 4 mm. longus, præter marginem glabram tenuiter puberulus, dentibus tubo 6-plo brevioribus late triangularibus, superioribus 2 connatis, breviter patentibus. *Petala* lilacina; vexilli lamina rotundata, in unguem brevem acuminata, dorso tenuiter sericea; alæ carinæque petala oblongæ, subhamatæ. *Stamina* monadelpha, vexillare basi solutum. *Discus* nullus. *Ovarium* lineare, multiovulatum. *Legumen* lineare, 15 cm. longum, 1·5 cm. latum, glabrum, lignosum, inter semina cohærens. *Semina* 5–8, lenticularia, 1 cm. longa.

CONGO FREE STATE: Mukenge, *Pogge*, 887 (Campine, *type*).

Differs from *M. drastica* in its pedicels being longer than the subglabrous calyx, and from *M. dura* by its smaller flowers, subglabrous calyx, and long narrow pod.

127. M. LASIANTHA, *Dunn in Journ. Bot.* xlix. (1911) 221.

Arbor parva, ramulis brevissime velutinis glabrescentibus lenticellatis. *Folia* 3-(rarius 4-)juga, 12–20 cm. longa, petiolis ter longiora; stipulæ caducæ; foliola lateralia superiora oblongo-obovata, acuminata vel acuta, apiculata, 5–7 cm. longa, papyracea, supra glabra, infra ut raches tenuiter adpresse brunneo-sericea, venis 8–9-paribus ascendentibus arcuatis supra inconspicuis infra prominulis; petioluli 2–3 mm. longi; stipellæ setaceæ, 3–4 mm. longæ. *Panicula* racemiformis vel ramosa, sæpissime terminalis, sessilis, rachi brevissime tomentosa; ramuli floriferi 3–10 mm. longi, sessiles, ut raches pedicellique vestiti. *Flores* approximati, 1·2 cm. longi; pedicelli 2–3 mm. longi; bracteæ minutæ, caducæ. *Calyx* campanulatus, 4 mm. longus, 3 mm. latus, dense adpresse brunneo- vel purpureo-hirsutus, bibracteolatus, dentibus tubo bis brevioribus; bracteolæ lanceolatæ, 1 mm. longæ. *Petala* cærulea; vexilli lamina ovata, basi sagittata, ungue bis breviore ad basin attenuato, dorso ut apices petalorum aliorum longe et laxe hirta; alæ oblongæ, basi obtusæ; carinæ petala ovata, subhamata. *Stamina* monadelpha, vexillare basi solutum mox omnino liberum. *Ovarium* lineare, sericeum, 4-ovulatum. *Legumen* immaturum oblongum, adpresse brunneo-sericeum.

Flowers in February to May.

GERMAN EAST AFRICA: *Holst*, 2968, 2215 (Usambara), *Holtz*, 1041 (Pugu), *Braun*, 1790 (Hemiafa), *Sacleux* (M'konda, *collected by* Dulhac), *Wakefield* (Nyika). All *types*.

128. M. LEUCANTHA, *Vatke in Oestr. Bot. Zeitschr.* xxix. (1879) 223; *Dunn in Journ. Bot.* xlix. (1911) 221.

Suffrutex, ramis ut paginis inferioribus foliolorum, rachi, pedicellis, calycibus dorsisque petalorum primo dense tomentoso-velutinis, ramis tandem glabris lenticellatis. *Folia* 3–4-juga, 12–18 cm. longa, petiolo 4-plo longiora, rachi primo hirta tandem glabra; stipulæ minutæ; foliolia lateralia superiora ovata vel sæpius late obovata, apiculata, basi rotundata, 5–7 cm. longa, coriacea, supra glabra nitida, subtus tandem tenuiter et laxe hirta, venis principibus 10–11-paribus subtus prominulis; petioluli 3–4 mm. longi; stipellæ setaceæ, 2–3 mm. longæ. *Panicula* terminalis, 9–17 cm. longa; rami floriferi ad 1 cm. longi, apice 3–4-flori. *Flores* fasciculati, 1·2–1·4 cm. longi; pedicelli 1–2 mm. longi; bracteæ bracteolæque obscuræ. *Calyx* 4 mm. longus, dentibus parvis. *Vexilli* lamina ovata, basi cordata, ecallosa, dorso longe hirta; alæ carinæque petala apice hirtæ basi truncatæ. *Stamina* monadelpha. *Ovarium* lineare, pluriovulatum.

Flowers in May.

BRITISH EAST AFRICA: Ukamba, *Hildebrandt*, 2789; *Kassner*, 807 (Galsusha, *type*).

129. M. BUSSEI, *Harms in Engl. Jahrb.* xxxiii. (1902) 170.

Frutex vel *arbor* 7–20 m. altus, cortice pallido, ramulis primo ferrugineo-tomentellis. *Folia* 3–4-juga, 15–25 cm. longa, rachi ut paniculis, pedicellis bracteis calycibusque tomentella; foliola lateralia superiora oblongo-obovata vel oblanceolata vel oblique ovata, apice rotundata, mucronata basi obtusa, 5–10 cm. longa, chartacea, primo utrinque sericeo-tomentosa, tandem supra tenuiter adpresse puberula, infra tomentella, venis marginem appropinquantibus 6–9-paribus erecto-patentibus infra prominulis; petioluli 3–4 mm. longi; stipellæ nullæ. *Paniculæ* racemiformes ex novellis enatæ, 10–20 cm. longæ, fere ad basin floriferæ, tomentellæ; ramuli floriferi ad 8 mm. longi, 2–3-flori. *Flores* laxe fasciculati, 1·7–2·0 cm. longi; pedicelli 6 mm. longi; bracteæ ramulorum florumque et bracteolæ anguste lineares, 6–8 mm. longæ. *Calyx* 8 mm. longus, dentibus 4, superiore cæteris latiori bidentato, inferiore cæteris angustiore, tubo paullo brevioribus. *Vexilli* lamina rotundata, dorso et ungue utrinque adpresse dense sericeo-pubescens, basi truncata bisacculata; alæ oblongæ, basi utrinque obtusæ et ibi ciliatæ; carinæ petala ovata, obtusa, ciliata. *Stamina* monadelpha, vexillare basi solutum. *Discus* calyci adnatus margine brevi libera. *Ovarium* lineare, pubescens, multiovulatum. *Legumen* lineare, acutum, 10 cm. longum, 2 cm. latum, valvis crassis lignosis dehiscentibus velutinis, 2–3-spermis.

Flowers in December.

GERMAN EAST AFRICA: *Busse*, 534 (Mananda, *type*), 1372, 2820 (Ruangwa), 2849 (Liho at Lagar Palikope).

130. **M.** SERICANTHA, *Harms in Engl. Jahrb.* xxviii. (1900) 404.

Frutex vel *arbor*? ramis primo breviter velutina, tandem glabris pallidis. *Folia* 3–4-juga, 20–30 cm. longa, petiolo 3-plo longiora, rachi ut pagina inferiore foliolorum paniculæ rachi pedicellis calycibusque breviter dense tomentosa; stipulæ persistentes, oblongæ, apice rotundatæ, 5 mm. longæ; foliola superiora lateralia ovato-oblonga vel ovata, apice rotundata, apiculata vel emarginata, basi obtusa vel acuta, 6–12 cm. longa, chartacea, supra tenuiter adpresse sericea, nervis marginem appropinquantibus 8–10-paribus subtus prominulis reticulatis; petioluli 4–6 mm. longi; stipellæ nullæ, nisi cristulæ in earum loco tenantur. *Paniculæ* racemiformes 9–16 cm. longæ, in novellis brevibus ante folia enatæ; nodi floriferi globulares vel ovales, 1–2 mm. longi. *Flores* fasciculati, 1·6 cm. longi; pedicelli 5–6 mm. longi; bracteæ bracteolæque 7–8 mm. longæ, lineares. *Calyx* campanulatus, 7–8 mm. longus, breviter dense pubescens, dentibus tubo 6–7-plo brevioribus. *Vexilli* lamina rotundata, basi truncata, dorso longe et laxe sericea, basi ut ungue breviter velutina; alæ oblongæ, uncinatæ, apice basique paullo hirtæ; carinæ petala oblonga, basi obtusa, similiter vestita. *Stamina* monadelpha, vexillare basi solutum. *Discus* ad annulum perigynum reductus. *Ovarium* lineare, pubescens, multiovulatum.

GERMAN EAST AFRICA: Uluguru Mts., *Goetze*, 142 (*type*).

131. **M.** GRACILIS, *Welw. ex Baker in Oliver, Fl. Trop. Afr.* ii. 129; *Hiern, Cat. Welw. Afr. Pl.* i. 227.

Arbor parva, gracilis, cortice lævi lenticellato. *Folia* 9–10-juga, 20–30 cm. longa, petiolo 5-plo longiora, rachi ut pagina inferiore foliolorum primo laxe hirsuta tandem glabra; stipulæ anguste lanceolatæ, mox deciduæ; foliola ad basin decrescentia, superiora lateralia oblongo-elliptica, apice retusa, basi paullo cordata, 4–6 cm. longa, glauco-viridia, papyracea, tandem glabra, venis marginem appropinquantibus 8–9-paribus, haud prominentibus; petioluli 2 mm. longi; stipellæ setaceæ, 1 mm. longæ. *Racemi* in novellis enati, præcoces, 15–20 cm. longi, fere ad basin floriferi, rachi ut pedicellis breviter velutina; nodi floriferi parvi, sessiles, pauciflori. *Flores* fasciculati, magnitudine variabiles, nonnunquam 9–10 mm. longi; pedicelli graciles, 3–4 mm. longi; bracteæ deciduæ; bracteolæ lanceolatæ, 1 mm. longæ. *Calyx* tenuiter sericeus, 2–3 mm. longus, dentibus brevibus latis. *Petala* intense violacea; vexilli lamina rotundata, basi obtusa, dorso dense sericea; alæ oblongæ, basi obtusæ, apice paullo pubescentes; carinæ petala ovata, basi truncata, apice ciliolata. *Stamina* diadelpha. *Discus* nullus. *Ovarium* sericeum, lineare, multiovulatum. *Legumen* lineare, 9 cm. longum, 1·3 cm. latum, facile dehiscens, glabrum; valvæ tenuiter lignosæ, inter semina cohærentes. *Semina* compressa, castanea, 8 mm. diam.

Flowers in March and October, fruits in September.

ANGOLA: *Welwitsch*, 1854–5; thickets on the mountains of Serra de Alto

Queta (*types*) ; Capopu on margins of forests ; Praia Cacarambola ; round Pemba, Ngombe, Zanga, and Cabinde.

Mr. Gossweiler tells me that it is largely grown in Angola as an ornamental tree. Like most of the Millettias, it loses its leaves just before flowering.

132. M. POLYPHYLLA, *Dunn.*—Derris polyphylla, *Baker in Journ. Linn. Soc., Bot.* xxv. (1890) 312, non *Benth.* ; (*sphalm.* polystachia), *Drake in Madag. Hist. Pl.* i. 190.

Arbor? ramis primo ferrugineo-tomentosis tandem glabris lenticellatis. *Folia* 17–19-juga, 16–18 cm. longa, petiolo 9-plo longiora, rachi tenuiter pubescens ; stipulæ lanceolatæ, obtusæ, 1·5 mm. longæ, tarde deciduæ ; foliola lineari-oblonga, apice obtusa, basi truncata, 2–2·5 cm. longa, papyracea, utrinque adpresse pubescentia, mox, præter costam, glabra, venis principibus 8–9-paribus, intra marginem quaque in proximam arcuatis inconspicuis ; petioluli 1·5 mm. longi ; stipellæ setaceæ, 1 mm. longæ. *Racemi* axillares, 12–15 cm. longi, basi nudi, rachi breviter tomentosa ; nodi floriferi 2–3-flori, globosi, sessiles vel subsessiles. *Flores* fasciculati, 11–13 mm. longi ; pedicelli 2–3 mm. longi ut calyx et dorsum vexilli adpresse sericei ; bracteolæ minutæ, lanceolatæ. *Calyx* 2–3 mm. longus, dentibus brevibus, tenuiter sericeus. *Vexilli* lamina rotundata, basi transverse plicata, in unguem brevem abrupte acuminata, dorso sericea ; alæ carinæque petala oblongæ, basi obtusæ vel truncatæ. *Stamina* monadelpha, vexillare basi solutum. *Ovarium* lineare, sericeum, multiovulatum.

MADAGASCAR, *Baron*, 5381 (*type*).

133. M. LENNEOIDES, *Vatke in Linnæa*, xliii. (1880–82) 335 ; *Vatke in Abh. Brem.* vii. (1882) 246 ; *Drake, Hist. Madag.* i. 140.—M. Grandidieri, *Baill. in Bull. Soc. Linn. Par.* i. (1883) 395 (fide *Drake*).

Arbor cortice glabro lenticellato. *Folia* 13–15-juga, 15–25 cm. longa, petiolo 7-plo longiora, rachi ut pagina inferiore foliolorum et rachi inflorescentiæ, primo breviter tomentosa, cito vel tardius glabra ; stipulæ lanceolatæ, obtusæ, 1·5 mm. longæ, tarde deciduæ ; foliola superiora lateralia anguste oblonga, apice obtusa vel retusa, basi rotundata vel obtusa, 2·5–3·5 cm. longa, papyracea, supra glabra, venis principibus 8–9-paribus intra marginem quaque in proximam arcuatis inconspicuis ; petioluli 1–2 mm. longi. *Racemi* axillares, 15–20 cm. longi, basi nudi ; nodi floriferi 2–3-flori, globulares, sessiles vel subsessiles. *Flores* fasciculati, 1·1–1·3 cm. longi ; pedicelli 3 mm. longi, ut calyces dorsaque vexillorum adpresse sericei ; bracteæ bracteolæque minutæ, lanceolatæ. *Calyx* campanulatus, 2–3 mm. longus, sericeus, dentibus brevibus. *Vexilli* lamina rotundata, basi abrupte angustata, transverse plicata ; alæ carinæque petala oblongæ, basi obtusæ vel truncatæ. *Stamina* monadelpha, vexillare basi solutum. *Ovarium* lineare, breviter stipitatum, multiovulatum. *Legumen* (*fide* Drake) oblongum, 10 cm. longum, 1·5 cm. latum, acutum, ad basin gradatim angustatum.

Flowers in March.

MADAGASCAR, *Hildebrandt*, 3370 (Vorberge des Ambóhitsi, Gebirges bei Nosi-Andiana, *type*), *Baron*, 4665, 6836.

134. M. THEUSZII (*vel sphalm.* Teuszii), *De Wild. in Ann. Mus. Congo*, sér. 5, i. 140, 260, t. 48, ii. 147 ; *De Wild. Mission Laurent*, 110 ; *De Wild. Compagnie de Kasai*, 311.—M. Chevalieri, *Harms in Engl. Jahrb.* xl. (May 1907) 35, *and in Bull. Soc. Bot. Fr. Mém.* viii. (Aug. 1907) 15. Lonchocarpus? Theuszii, *Büttner in Verhandl. Bot. Ver. Brandenb.* xxxii. (1891) 51.

Arbor ramis ferrugineo-tomentosis glabrescentibus. *Folia* 4–6-juga, 15 cm. longa, tenuiter albo-tomentosa ; foliola superiora lateralia oblonga vel obovata, basi rotundata, brevissime acuminata, 7–8 cm. longa, subcoriacea, supra glabra, glauca, subtus adpresse dense aureo-sericea, venis marginem approximantibus 8–10-paribus supra tenuiter reticulatis subtus prominulis ; petioluli 4–5 mm. longi ; stipellæ setaceæ, 1 mm. longæ. *Panicula* terminalis, 30–40 cm. longa, cum ramis brevibus rigidis erecto-patentibus breviter rufo-tomentosa ; rami ad basin nodis approximatis obsessi; nodi 4–5-flori, globulares, sessiles. *Flores* fasciculati, 2·4-2·6 cm. longi ; pedicelli 1·7 cm. longi, medio duabus bracteolis caducis provisi. *Calyx* obconico-campanulatus, 1·1 cm. longus, rubro-velutinus, dentibus 4 tubo æquilongis. *Vexilli* lamina rotundata, basi cordata, ungue 10-plo longior, dorso breviter sericea, exauriculata ; alæ carinæque petala oblongæ, apice angustatæ, basi subhamatæ. *Stamina* diadelpha, antheris protrusis. *Discus* calyci adnatus, longitudinaliter corrugatus. *Ovarium* lineare, 6-ovulatum, sericeum. *Legumen* in pedicello 1·2–1·8 cm. longo, 17–20 cm. longum, 2–3·5 latum, 3–4 mm. crassum, dehiscens, valvis breviter rubro-brunneo-velutinis. *Semina* 5–6, brunnea, 2 cm. lata.

Flowers in September to January.

FRENCH CONGO : Brazzaville, *Chevalier*, 11172.

CONGO FREE STATE, *Rensch*, 517.

ANGOLA : San Salvador, *Büttner*, 455 (*type*), 755.

Dr. Harms himself pointed out to me the identity of his *M. Chevalieri* with Büttner's species.

NUMERI COLLECTORUM VEL COLLECTIONUM.

Abdul Huk, 51 ovalifolia, 147 Brandisiana, 173 pendula.

Amani Inst. Herb., 1486, 1662 *a*, 2292 oblata.

Assam Forest Herb., 700 auriculata.

Badal Khan, 10 auriculata, 142 tetraptera.

Bagshaw, 357 cyanantha, 1071 dura.

Balansa, 2300, 2302–4 eurybotrya, 2236–7 ichthyochtona, 2306 pachyloba, 2238–9 setigera, 1205, 2230 speciosa.

Barber, 3107 rubiginosa.

Barchet, 128 Dielsiana.

Baron, 4665, 6836 lenneoides, 5381 polyphylla.

Barter, 148, 1806 aboensis, 67, 1609, 3253, 3401 Barteri, 1597 sanagana, 481, 1618, 1624 Thonningii.

Bates, 59 macrophylla.

Battiscombe, 26 usaramensis.

Baumann, 128 Thonningii.

Beccari, 3070 glaucescens.

Beddome, 37 auriculata, 14 glaucescens, 33, 1900, 1901, 1903 racemosa.

Bons d'Anty, 244, 251 leptobotrya.

Braun, 1544 oblata, 1790 lasiantha.

Brazza & Thollon, 78 Laurentii.

Buchwald, 79, 144 oblata.

Busse, 534, 1372, 2820, 2849 Bussei, 2920 eriocarpa, 2851 usaramensis, 3449 Zechiana.

Büttner, 455, 755 Theuszii.

Cabra, 110 Cabræ.

Cave, 177 Prainii.

Champion, 263 Championi, 261, 505 speciosa.

Chevalier, 12378, 12399 aureocalyx, 13174, 13244, 14356, 16984, 18206 Barteri, 15002, 19895 chrysophylla, 16829, 22640, 22644 hirsuta, 5081 macroura, 12637 pallens, 12507 porphyrocalyx, 19110 rhodantha, 12053, 12165, 12737, 13091 sanagana, 11172 Theuszii, 23271, 23730 Thonningii, 4112, 11377 versicolor, 19142, 19740, 22473 Zechiana.

Clarke (C. B.), 9040 C, 11685, 11687, 13829 H, 21295 B, 26551 E, 33758 B auriculata, 5514 caudata, 11850, 11850 G, 27976 D, 40235 B, 40310, 44038 C, 44106 A cinerea, 17739 A, 43242 C, 43280 B, 44208 pachycarpa, 15194, 43713, 44713, 7328 pulchra.

Collett, 15 Brandisiana, 620 Cubitti, 759, 773 Dorwardi, 601 glaucescens, 443, 605 macrostachya, 516, 553 multiflora, 436, 482 pendula.

Conrau, 71 Conraui.

Craib, 409 cinerea.

Cubitt, 226 Cubitti, 51, 332, 288 Dorwardi.

Curtis, 2459 albiflora, 844, 2967 sericea, 1615 unifoliata.

Dalziel, 23, 404 Thonningii.
Dawe, 452, 459, 481 dura, 312, 511 Stuhlmanni, 446, 513 usaramensis.
Dennett, 15 aboensis.
De Vore & Hoover, 250 litoralis.
De Wevre, 773 congolensis.
Diepenhorst, 695 sericea.
Dinklage, 785 coruscans, 1672, 1964 Dinklagei, 1787, 1962, 1994 pallens, 2632 Zechiana.
Duchesne, 4 Duchesnei.
Ducloux, 810 Bonatiana, 375, 384, 389 Dielsiana, 2 pulchra.
Dun, 99 Brandisiana.
Eich, 166 oblata.
Ellenbeck, 1725 ferruginea.
Elliott, 36, 37 Thonningii.
Elmer, 6166 Merrillii.
Faber, 757, 758, 773, 774 Dielsiana.
Falconer, 572 auriculata.
Farmar, 259 pallens.
Farquarson, 70 melanocalyx.
Faurie, 146, 164 reticulata.
Fischer, 194 paucijuga.
Fisher, 1412 racemosa.
Forbes (F. B.), 592 nitida, 122, 862 reticulata, 589 Championi.
Forbes (H. O.), 2916 nivea, 3103 A sericea.
Ford, 63 Dielsiana, 62 Fordii, 371 oosperma, 35 oraria, 368 pachyloba, 38, 403, 503, 644–5 pulchra, 10, 36, 37, 43 reticulata.
Fortune, 17 Dielsiana, 68, A 95 reticulata.
Foster, 21 Thonningii.
Fox, 10788 pterocarpa.
Gallatly, 29, 573, 903 auriculata, 107, 147, 160 Brandisiana, 383, 701 cinerea, 725 pachycarpa, 562 pubinervis, 531 puerarioides, 198 pulchra, 61 racemosa.
Gamble, 8843 auriculata, 2105, 2107 A, 492 C, 9844, 10525 cinerea, 765 A, 765 C, 1103 A, 2102 A, 6669 B pachycarpa, 689 B, 2238 A, 2240 C Prainii, 9311, 16507, 13847, 18566, 18716 racemosa, 14353, 16195, 17778, 22580 splendens.
Gammie, 420, 488, 492 pulchra.
Gerrard, 9 caffra.
Goetze, 11 Goetzeana, 207 eriocarpa, 1309 oblata, 142 sericantha.
Goodenough, 1706 sericea.
Gossweiler, 491 Thonningii.
Griffith, 1787 auriculata, 1176, 1766, 1785, 1786 cinerea, 1771, 1813 fruticosa, 1783 Griffithii, 1767 pachycarpa, 67, 1768 Piscidia, 1784, 1791 pulchra, 1764 sericea.

Griffon, 693 macrophylla.
Haines, 783 racemosa.
Hance, 21961 sericosema, 1489 reticulata.
Hasskarl, 3997 sericea.
Henry (*A.*), 10939 Cubitti, 1584, 1938, 2917, 3074, 9633, 10813 Dielsiana, 12792, 12792 A leptobotrya, 8235, 10265, 10670 B, C, 12292 A oosperma, 10521, 13000, 13530 pachycarpa, 8498 pachyloba, 994, 12322, 13031 pulchra, 68, 631, 894, 1554 A, 2280, 2333, 4211, 8392 reticulata, 8341 speciosa, 9728, 9728 B, 9728 D, 9728 F velutina.
Henry (*B. C.*), 45 pulchra.
Heudelot, 803 Barteri, 793 pallens, 815 rhodantha.
Heudner, 80 ferruginea.
Hildebrandt, 3370 lenneoides, 2789 leucantha.
Holland, 201 aboensis.
Holmberg, 834, 888 sericea.
Holst, 2968 lasiantha, 2215, 2968 leucantha, 620 oblata, 2948 usaramensis.
Holtz, 1041 lasiantha, 183 oblata, 1227 Sacleuxii, 987, 1004 usaramensis.
Hongkong Herb., 1253, 9393 Championi, 1799, 2579, 4805, 5059, 7094, 9394 Dielsiana, 8527 japonica, 1903 nitida, 1428 oosperma, 2564 pachycarpa, 6638 pachyloba, 1151, 1754, 2588, 6860, 9397 reticulata, 1181, 2011, 4806, 6631, 9341 speciosa.
Hooker & Thomson, 2399 cinerea, 1724 Piscidia, 698 pulchra.
Horsfield, 23 sericea, 48 unifoliata.
Hosseus, 140 Brandisiana.
Johnson (*W. H.*), 456, 911 Thonningii, 464 Zechiana.
Johnston (*H. H.*), 68 pallens.
Junghuhn, 48, 72, 223 sericea.
Kandt, 112 dura.
Kässner, 807 leucantha.
Kerr, 595, 1724 auriculata, 985, 2029 Brandisiana, 2579 cærulea, 1733 latifolia, 1770 pachycarpa, 1452 pubinervis.
King, 833, 871, 2423, 4826 cinerea.
King's Collector, 38, 60, 384, 541 cinerea, 10718 Hemsleyana, 188 pulchra, 401, 3179, 3960, 4042, 5804, 6844, 7019, 7299, 7366, 7493, 10479 sericea.
Klaine, 5, 69 Barteri, 569 Gagnepainiana.
Koorders et Valeton, 4105, 14191 dehiscens.
Korthals, 873 sericea.
Krauss, 194 caffra.
Kunstler, 729, 4201, 4467, 5357, 5833, 5993, 6077, 6709, 6842 albiflora, 4251, 4267, 4492, 8210 unifoliata.
Kuntze, 5975 dehiscens, 5564 pachycarpa.

Kurz, 1774, 2534 auriculata, 1773, 2538 Brandisiana, 121, 204 cinerea, 1777, 2613 glaucescens, 2605, 2606 ovalifolia, 142, 306 pachycarpa, 1769, 2600 pendula, 325 Piscidia, 1778 pubinervis, 1765 puerarioides, 1722 racemosa.

Lace, 3135, 3282 auriculata, 2710, 4181, 4435, 4529, 4674 Brandisiana, 5730 Cubitti, 5797, 5849 Dorwardi, 4721 pubinervis, 3289 pachycarpa, 4167, 4530 pendula.

Lamont, 161 A, reticulata, 160 speciosa, 158–9 nitida.

Lecomte, D 97, 723 Barteri, A 8 bicolor, D 103 Lecomtei.

Ledermann, 2754 Conraui, 2082, 2070, 2572 drastica, 6182 macrophylla.

Lemann, 359 cinerea.

Leslie, 340 cinerea.

Lister, 402 cinerea.

Lobb, 310 sericea.

Loher, 2413–6 Merrillii.

Luang Vanpruck, 188 racemosa.

MacGregor, 808 auriculata, 803 cinerea, 618 pulchra, 216 Thonningii.

Maingay, 606, 1191 albiflora, 518, 1182, 1184 sericea.

Maire, 156 Bonatiana, 163 Dielsiana, 142, 165 pulchra, 160 velutina.

Mann, 512 aboensis, 822 Barteri, 2259 calabarica, 1743 coruscans, 2216 Stapfiana.

Marques, 33 drastica.

Meebold, 7847, 15560 auriculata, 15536 ovalifolia, 7123 pachycarpa, 7823 podocarpa, 5337 pulchra, 13078 rubiginosa.

Merrill, 4181 cavitensis, 1387, 1625, 1633, 2801, 3831, 9821 Merrillii.

Milbraed, 2466, 2355 drastica, 2479 dura, 3209 psilopetala.

Mokim (*Shaik*), 1471, 1721 auriculata, 1322 Brandisiana, 469, 1083 cana, 79 puerarioides, 1576 racemosa, 636 tetraptera.

Morse, 23 Bonatiana, 582 Dielsiana, 294, 648 oosperma.

Oldham, 386, 801 japonica, 158 reticulata.

Parker, 107 pulchra.

Philippine Bureau of Science, 12436 Ahernii, 4711, 4727 canariifolia, 740 Foxworthyi, 2178 Merrillii, 1064 racemosa.

Philippine Forestry Bureau, 3373, 5221, 5655 Ahernii, 18549 capillipes, 13815 cavitensis, 11140 stipulata.

Plant, 20 caffra.

Playfair, 120 reticulata.

Pogge, 887 leptocarpa, 838 macroura.

Poole, 6 rhodantha.

Prain's Collector, 438 pachycarpa, 52 Prainii.

Prazer, 23 auriculata, 7 pachycarpa, 64 pendula.

Preuss, 1187 Barteri, 258 Mannii, 411 melanocalyx.

Proudlock, 94 ovalifolia.

Quintas, 113 Thonningii.
Rensch, 517 Theuszii.
Reporter on Econ. Prod. to Govt. Ind., 29992, 18078, 20204, 23348, 29462 auriculata, 10263, 12062, 12415, 26072, 29928 pachycarpa.
Ribu & Rhomoo, 3614 Prainii.
Ridley, 2641, 8598, 10596 albiflora, 2591–2, 14677 Hemsleyana, 7981, 8004 unifoliata.
Ritchie, 1719 racemosa.
Robertson, 289 macrostachya, 126 trifoliata.
Rodger, 305 pulchra.
Rosthorn, 1626, 1638 Dielsiana.
Rudatis, 13 hypolampra.
Sacleux, 2047 Sacleuxii.
Sapin, D 1 Sapini.
Scheffler, 212 oblata.
Schimper, 279, 861 ferruginea.
Schlagintweit, 271 Piscidia.
Schweinfurth, 3189, 3227 Barteri, 3470 drastica.
Scortechini, 1288, 1948 albiflora, 1749 decipiens, 1797 sericea, 124, 1023, 1711 unifoliata.
Scott Elliot, 4202 Barteri, 7544 dura, 4241 lucens, 4609, 5839 pallens, 4598, 5225 B, 5771 sanagana, 5126 A Scott-Ellioti.
Searlight, 219 cinerea.
Seret, 793 Sereti.
Shaik Mokim see *Mokim*.
Shaw, 23 Barteri.
Sierra Leone Herb., 7 pallens.
Smith (Christian), 63 Barteri, 60 drastica, 38, 40, 43, 52, 74 impressa.
Smythe, 66 sanagana, 127 Zechiana.
Soyaux, 444 Barteri, 57 drastica, 99 impressa, 96 Soyauxii.
Staudt, 92 Barteri.
Stuhlmann, 6750 micans, 1625, 8833, 9285 oblata, 668, 856, 868 Stuhlmanni, 1039, 6358, 7044, 7456 usaramensis.
Swinhoe, 1489 reticulata.
Swynnerton, 145–6, 1396, 1428 Stuhlmanni, 1425, 1474 usaramensis.
Talbot, 590 racemosa.
Talbot (P. A.), 578 hypolampra.
Tessmann, 412 aboensis, 834 drastica, B 136 Harmsiana, B 228, 940 Laurentii.
Teysmann, 6026 ovalifolia, 5984 pendula.
Thollon, 486 Tholloni.
Thompson (H. N.), 5 aboensis.
Thomson, 852 auriculata.
Thomson (W. C.), 64 Barteri.

Thonner, 268 Thonneri.
Unwin, 24 Thonningii.
Vasse, 297 Stuhlmannii.
Verdick, 55 brevistipellata.
Vidal, 2573 cavitensis, 240, 1243 Foxworthyi, 2572 Merrillii.
Vogel, 117 macrophylla.
Wallich's Catalogue, 909 C, 5892, 5892 A, 5900 auriculata, 5894 cærulea, 5903 cana, 5895 caudata, 5887, 5888, 5888 A, 5889, 5903–4 cinerea, 909, 909 B fruticosa, 5902 pendula, 5630, 5630 C pulchra, 5891, 5914 racemosa, 5976–7 tetraptera, 5918 Brandisiana.
Wangenheim, 8 usaramensis.
Warburg, 12094, 12095, 12112 longipes, 12578, 12891 Merrilii.
Warnecke, 46 oblata, 66 Thonningi, 108 Warneckei.
Watt, 5032 cinerea, 7257 pachycarpa, 6254, 6746, 11758 pulchra.
Weber, 1123 platyphylla.
Welwitsch, 1852–3 aromatica, 1856–8 drastica, 1854–5 gracilis, 1850 nudiflora, 1859 versicolor.
Wight, 245–6, 813, 912 rubiginosa, 807, 998 splendens.
Wilford, 146 nitida, 462 reticulata.
Williams, 24 aboensis.
Wilson, 824, 1089, 3412, 3412 A, 3413, 4834–5 Dielsiana, 3414 pachycarpa, 1017, 1648 reticulata.
Wood (Medley), 326, 650, 1025 caffra.
Wray, 1864, 1943 albiflora, 168 pterocarpa, 548, 3308, 3310, 3608 Hemsleyana, 2178, 2364, 3164 sericea, 2836 unifoliata.
Wright (C.), 136 Championi, 137 Dielsiana, 138 speciosa.
Zenker, 317 aboensis, 971, 1029, 1703, 2367, 2532, 3266, 3440, 3796 Barteri, 2299 bipindensis, 670, 711 drastica, 3110 macrophylla, 100, 1009, 1173 Mannii, 1466, 2449 sanagana.
Zenker et Staudt, 100 aboensis.
Zimmermann, 1113 A, 2194 oblata.

Species excludendæ.

M. ADENOPETALA, Taub. in Engl. Jahrb. xxxiii. (1902) 184 = *Schefflerodendron adenopetalum*, Harms.

M. ATROPURPUREA, Benth. in Pl. Jungh. 249 = *Adinobotrys atropurpureus*, Dunn in Kew Bull. 1911, 197.

M. BAPTISTARUM, Büttn. in Brandenb. Verhand. xxxii. (1891) 50 = *Craibia Baptistarum*, Dunn in Journ. Bot. xlix. (1911) 109.

M. BARONI, Drake, Hist. Pl. Madag. i. 141. The inflorescence is not known, but the leaves and fruit bear a close resemblance to those of *Mundulea* *hysterantha,* Baker, with which it is possibly conspecific, certainly congeneric.

M. BLACKII, F. v. Muell. Fragm. ii. 123 = *Lonchocarpus Blackii,* Benth. Fl. Austral. ii. 271.

M. BOGERI, Vatke in Bremen Abh. vii. (1882) 246. The type from Berlin has been compared with the type of *Mundulea revoluta,* Baker, at Kew, and proves to be conspecific, and therefore a true *Mundulea.*

M. BREVIFLORA, De Wild. in Ann. Mus. Congo, sér. 5, i. 136 = *Ostryocarpus lucidus,* Dunn in Kew Bull. 1911, 363.

M. CAULIFLORA, Prain in Journ. As. Soc. Beng. xlvi. II. (1897) 94, 363 = *Fordia pauciflora,* Dunn, comb. nov. (non *Fordia cauliflora,* Hemsl.).

M. CHINENSIS, Benth. in Miq. Pl. Jungh. 249 = *Wistaria chinensis,* DC. Prodr. ii. 390.

One of the true Wistarias.

M. ERIANTHA, Benth. in Plant. Jungh. 250 = *Adinobotrys erianthus,* Dunn in Kew Bull. 1911, 194.

M. FLORIBUNDA, Matsum. in Bot. Mag. Tokyo (1902) 64 = *Wistaria chinensis,* DC.

M. GRACILLIMA, Hemsl. in Kew Bull. 1895, 134. Solomon Is.

Quite unlike any *Millettia* known. From its want of stipules, few leaflets, lax inflorescence, and few ovules, it is more likely to prove a *Derris.*

M. GRIFFONIANA, Baill. Adans. vi. (1866) 222 = *Lonchocarpus Griffonianus,* Dunn in Journ. Bot. 1911, 15.

M. MADAGASCARIENSIS, Vatke in Linnæa, xliii. (1880–82) 101 = *Lonchocarpus polystachyus,* Baker, an undoubted *Lonchocarpus.*

M. MAINGAYI, Baker in Hook. f. Fl. Brit. Ind. ii. 110 = *Padbruggea Maingayi,* Dunn in Kew Bull. 1911, 198.

M. MAKONDENSIS, Harms in Engl. Jahrb. xxxiii. (1902) 169.

Apparently herbaceous. Its racemes are simple, axillary, and its pistil 2-ovulate. These characters do not occur elsewhere in *Millettia,* and the species should perhaps be referred to some other genus.

M. MICRANTHA, Harms in Engl. Jahrb. xxvi. (1899) 290, is an *Ostryocarpus.*

M. MONOPHYLLA, Harms in Engl. Jahrb. xxvi. (1899) 288 = *Eriosema ellipticum,* Welw. *fide* Harms *in litt.*

M. MONTICOLA, Kurz in Journ. As. Soc. Beng. xlii. II. (1873) 67 = *Derris monticola,* Prain in Journ. As. Soc. Beng. lxvi. II. (1897) 361. Prain here points out that this name may have to be superseded by *D. secunda,* Baker, a type specimen of which he had not seen. The writer has, however, compared Kurz's specimens with this type, which is apparently only represented in the Wallichian Herbarium (under the name of *Amerimnum secundum*, Ham.). Its flowers, and especially the calyx, are considerably smaller, only 8 and 2 mm. long respectively, and it is in general a very different species to *M. monticola,* so that Prain's name should stand.

M. NIEUWENHUISII, J. J. Sm. in Bull. Dép. Agric. Ind. Néerl. iii. 17 = *Adinobotrys Nieuwenhiusii,* Dunn in Kew Bull. 1911, 196.

M. OOCARPA, Prain in Journ. As. Soc. Beng. lxvi. II. (1897) 365 = *Padbruggea dasyphylla*, Miq.

M. PANICULATA, Miq. Fl. Ind. Bat. Suppl. 301. The type specimens from the Leiden Herbarium show that it is a mixture of two species, neither of them *Millettia.* Miquel placed flowers of *Derris thyrsiflora* with fruit of *Adinobotrys atropurpureus,* being deceived by the similarity of the leaves and arrangement of the pedicels.

M. PIRIFOLIA, Vatke in Oestr. Bot. Zeitschr. xxviii. (1878) 215, is a *Baphia.*

M. SCABRICAULIS, Franch. in Pl. Delav. i. 158, is apparently a *Derris.*

M. SPECIOSA, Welw. Apont. 585 = *Lonchocarpus sericeus,* H. B. K. (*fide* Hiern).

M. STIPULARIS, Prain in Journ. As. Soc. Beng. xlvi. II. (1897) 363 = *Fordia stipularis,* Dunn in Kew Bull. 1911, 64.

M. SUTHERLANDI, Harv. in Harv. & Sond. Fl. Cap. iii. 211, is a *Lonchocarpus.*

M. THYRSIFLORA, Benth. in Miq. Pl. Jungh. 249 = *Derris thyrsiflora,* Benth.

M. ZENKERIANA, Harms in Engl. Jahrb. xxvi. (1899) 291 = *Ostryocarpus Zenkerianus,* Dunn in Kew Bull. 1911, 362.

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M. AMYGDALINA, Baill. in Bull. Soc. Linn. Par. i. (1883) 396. The description suggests *Leptoderris.*

M. ANTSAHALANBENSIS, Baill. *l. c.* 395 ; Drake, Hist. Madag. i. 140. The very meagre descriptions are quite insufficient to place it even generically. A photograph from a type specimen at Paris shows it to have a terminal raceme, and its general appearance in conjunction with that character render it probable that it is a *Mundulea.*

M. ARGENTEA, Miq. Fl. Ind. Bat. i. 156.—*Dalbergia argentea*, Zippel, *ex* Miq. *l. c.* The type in the Leiden Herbarium (Herb. Lugd.-Bat.) is a portion of a climbing leafy shoot with twining petioles, and from the latter character can hardly be included in *Millettia*. The absence of flowers and fruit renders even its generic identification impossible.

M. ATENENSIS, De Wild. Compagnie du Kasai (1910), 309.

The description is from leaves and young flower-buds. It can only be conjectured that it is a *Millettia* of the section *Efulgentes*, perhaps near *M. urophylloides*.

M. CHAPELIERI, Baill. in Bull. Soc. Linn. Par. i. (1883) 395; Drake, Hist. Madag. i. 140.

The description is meagre and leaves the genus doubtful, but it is more likely to prove a *Craibia* than a *Millettia*.

M. LUZONENSIS, A. Gray, Bot. U. St. Expl. Exped. i. 456. No specimen has been seen, and the description hardly warrants its inclusion in *Millettia*.

M. PISCATORIA, Merrill in Philipp. Gov. Lab. Bur. Bull. xxvii. 37.—*Cylista piscatoria*, Blanco, Fl. Filip. ed. 1, 589. *Galactia terminiflora*, Blanco, *l. c.* ed. 2, 411.

No specimen has been seen.

M. ROSTRATA, Miq. Fl. Ned. Ind. i. 155.—*Dalbergia rostrata*, Hassk. Flora.

The descriptions are from foliage only, and leave the genus quite doubtful.

M. SPLENDIDISSIMA, Blume, *ex* Miq. Fl. Ind. Bat. i. 156. The type consists of leaves only, so that the genus cannot be determined. It has, however, the look of a *Fordia*, and may prove to be *F. filipes*.

M. XYLOCARPA, Miq. Fl. Ned. Ind. i. 157. The specimen in Horsfield's own herbarium at the Linnean Society's Rooms consists of foliage and pods, and there is nothing to show that Miquel was not right in referring it to *Millettia*. Flowers, however, would be necessary to verify his conclusion. It is exstipellate, and the pod shows that the pistil was 5-ovulate.

M. ZOLLINGERIANA, Miq. Fl. Ind. Bat. i. 156. The very meagre description leaves the genus doubtful.

FORNASINIA EBENIFERA, Bertol. Misc. Bot. viii. (1849) 18, t. i., is known to me only from the description and figure quoted, which, while leaving no doubt as to the genus, cannot be definitely reduced or placed as a species.

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(PLATES **10–13** and 1 Text-figure.)

[Read 2nd May, 1912.]

WHILE working out at Kew the collection of botanical specimens which I gathered mainly on my travels in the North and the interior of Queensland in 1909–1910, I obtained permission to study the unnamed Australian material in the Herbarium of the Royal Botanic Gardens at Kew. In the present paper I propose to give descriptions of new species and varieties found in those collections, and also to enumerate others which were already described, and especially such as are remarkable for their variability or were up to the present imperfectly known.

The bulk of the material consisted of two very valuable and interesting collections of plants—one from North-Western Australia (between the Ashburton and De Gray Rivers) made by Dr. E. Clement, and the other from Western Australia by Capt. A. A. Dorrien-Smith, D.S.O. Dr. Clement's collections prove that the flora of the region he explored is quite different in character from that of extra-tropical Western Australia, and much more similar to the plant-formations of Northern Australia and North-Eastern Queensland. Only a few of the characteristic species extend to extra-tropical Western Australia, which region is now fairly well known, more especially since Dr. L. Diels's standard work, "Die Pflanzenwelt von West-Australien südlich des Wendekreises" (Veget. der Erde, vii. Leipzig, 1906). Capt. A. A. Dorrien-Smith, however, found several new and very interesting species, some even in localities previously visited by botanists or botanical collectors, and there seems to be in this region of the world practically no limit to the number of allied though distinct species especially in the sand-plains.

For the full account of the description of the localities visited by Capt. A. A. Dorrien-Smith I refer to his own report in the Journal of the Royal Horticultural Society (vol. xxxvi. (1910) pp. 285–293: "A Botanizing Expedition to West Australia in the Spring (October, 1909)"), which is accompanied by some views of the vegetation.

In the present contribution I include only Monocotyledons, Ferns, and the Casuarina; for practical reasons I thought it advisable to follow Bentham's 'Flora Australiensis' in the systematic arrangement. I hope later on to work out the numerous Dicotyledons brought by Dr. Clement and Capt. Dorrien-Smith, and to give a phytogeographic and statistic account of the North-West Australian flora and its relations with the floras of other parts of Australia and of the neighbouring countries[*].

I. DICOTYLEDONEÆ.

CASUARINACEÆ.

Casuarina, *L.*

Casuarina Dorrienii, *Domin*, sp. n. (Plate **13**. figg. 25–27.)

Arbor vel frutex elatus probabiliter dioicus ramulis permultis erectis; *rami* vetustiores crassi fusci striato-sulcati glabri, ramuli tenues sed rigidiusculi diametro 1 mm. vel paulo latiores costati glauci et tantum sub dentibus luteoli; *internodia* mediocriter longa (circa 11–20 mm.); *dentes* **9** subpatuli lanceolati glabri circiter ¾ mm. longi acuti pallide brunnei tantum basi intensius colorati (fusci). *Amenta* mascula perangusta ramulis paulo latiora elongata usque **3** cm. longa internodiis circa 15 usque 20 brevibus instructa; dentes iis ramulorum similes, sed manifeste subpatuli in vaginas subcampanulatas connati. *Strobili* fœminei sub flore parvi subglobosi manifeste pedicellati; pedicelli verticillis pluribus (circa 6) approximatis imbricatis obtecti; bracteæ lineari-lanceolatæ; strobilus subsessilis breviter late cylindricus vel elliptice cylindricus basi et apice truncatus

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[*] For more detailed information I refer to the following sources:—

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—— Plants of North-Western Australia, 1881.

—— The Plants Indigenous around Sharks Bay and its vicinity. Perth, 1883.

circa 2 cm. longus et 15 mm. et ultra latus circa 9-stichus, bractea parva, bracteolæ basi connatæ exsertæ, partis liberæ dorsum valde incrassatum carinato-convexum extus brunneum et cinereo-griseum glabrum intus fulvum et dense pilosulum. *Semina* alata oblique obovata ad basin obtusam angustata circa 5½–6 mm. longa et parte superiore, qua latissime patent, 2¼–2¾ mm. lata; achænia atrofusca, ala pallida.

W. Australia: Warrungup Hill, Stirling Range, collegit A. A. Dorrien-Smith, in cujus honorem speciem hanc pulchram nominavi.

C. Dorrieni in affinitatem *C. Huegelianæ*, Miq. et *C. campestris*, Diels spectat sed ab utraque specie satis superque distat.

C. Huegeliana habet amenti masculi internodia numerosa (25–40), strobilos subglobosos vel ellipsoideos, bracteolas dorso incrassatas sed haud manifeste carinatas et semina angustiora alis apicem versus haud dilatatis ut in specie nostra.

C. campestris, Diels (Fragm. 126) excellit amenti masculi internodiis minus numerosis (10–20), strobilo ellipsoideo multo longiore et bracteolis sulca quadam sub apice signatis.

C. Dorrieni mihi in ramis tribus obiacet; unus strobilos maturos, alter florentes, tertius amentos masculos fert.

II. MONOCOTYLEDONEÆ.

ORCHIDACEÆ.

THELYMITRA, *Forst.*

TH. ARISTATA, *Lindl.* (Bentham, vi. 319).

W. Australia: Warrungup Hill, Stirling Range, coll. Capt. A. A. Dorrien-Smith, 1909.

Species variabilis esse videtur, sed formas occidentales (*T. macrophylla*, Lindl.) ut iam Bentham recte commemorat et formas in Victoria et Tasmania crescentes specifice distinguere nequimus. Planta nostra est fructifera sed cum speciminibus a cl. Drummond, Oldfield et Dempster in Australiæ occidentalis locis diversis collectis bene convenit.

TH. VILLOSA, *Lindl.* (Bentham, vi. 320; Diels, Fragm. 117).

W. Australia: Slab Hut Gully usque Cranbrook; Mallet; Bridgetown usque Kojonup, leg. A. A. Dorrien-Smith, 1909.

Floribus luteis eximie purpureo-punctatis gaudet.

TH. ANTENNIFERA, *Hook. f.* (Bentham, vi. 322; Diels, Fragm. 117).

W. Australia: prope Mallet, leg. A. A. Dorrien-Smith, 1909.

THELYMITRA CAMPANULATA, *Lindl.*

W. Australia: Mt. Toolbrunup, coll. A. A. Dorrien-Smith, 1909.

Species adhuc dubia, a cl. Lindley (Swan River, Append. p. 49), ut sequitur, descripta: "Folio radicali lineari, racemo secundo multifloro, floribus purpureis campanulatis, cuculli laciniis lateralibus subulatis apice barbatis intermedia tripartita dorso glandulosa."

Planta nostra haud est cum *Th. canaliculata* comparanda * et etiam a *Th. ixioides*, Sw.. cui est affinis, me judice specifice separanda. Descriptio Lindleyana est manca, sed cæterum plantam nostram bene quadrat. Verosimiliter sistit formam vel varietatem *Th. campanulatæ*, a typo diversam racemis paucifloris et floribus parvis. Perianthium supra globoso-concavum esse videtur.

DIURIS, *Sm.*

D. SETACEA, *R. Br.* (s. ampl.).

W. Australia: Bridgetown usque Kojonup et Slab Hut Gully, leg. A. A. Dorrien-Smith, 1909.

D. SETACEA, *R. Br.*, var. EMARGINATA, *Domin*, comb. n. (*R. Br.* pro sp.; Bentham, vi. 330).

Cum præcedente.

D. setaceæ, R. Br. et *D. emarginatæ*, R. Br. speciminibus numerosissimis examinatis nullam differentiam constantem majorisque valoris invenire possum; me judice formæ hæ pro varietatibus unius ejusdemque speciei habendæ sunt. *D. setacea* var. *typica* caule pro more humiliore, foliis angustis filiformibus, floribus in racemo paucis et minoribus, *D. setacea* v. *emarginata* caule multo elatiore, foliis latioribus linearibus, floribus majoribus et in racemo pluribus excellit.

Formæ typicæ characteribus indicatis gaudentes primo aspectu facile distinguuntur, sed formæ numerosæ intermediæ eas tantum pro varietatibus et nullo modo pro speciebus distinctis vindicant.

In herbario Kewensi formam reperi, quæ in parte vegetativa *D. emarginatam*, in racemo et floribus *D. setaceam* optime quadrat.

Formam *D. setaceæ* summopere parvifloram cl. Oldfield in Australia occidentali collegit (Mt. Barker, No. 594). Etiam flores modo punctati (ut specimina a cl. Dorrien-Smith allata), modo æqualiter lutei apparent.

Formæ complures pro speciebus distinctis primo aspectu habendæ constantes esse videntur, sed si specimina numerosa e multis regionibus inter se compares, in formas intermedias et dubias abeunt.

Formam caulibus valde humilibus sed floribus conspicuis magnis haud punctatis excellentem cl. Burges anno 1860 in Australia meridionali-occidentali collegit. Ad formam hanc proxime accedunt specimina a cl. E. Pritzel in Australia oocidentali in distr. N. West Plantagenet in arenosis m. Nov. 1901 lecta (sub numero 956) et pro *D. pauciflora* declarata, quæ me judice pro varietate propria salutanda sunt.

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* The middle lobe of the hood is crested on the back as in *Th. ixioides*, while it has no dorsal crest in *Th. canaliculata*.

Cl. L. Diels et O. H. Sargent certe non immerito monuisse videntur cl. Bentham sub *D. setacea* duas species distinctas (sed valde affines) conjunxisse, i. e. *D. setaceam* veram carinis labelli duabus in unam apice confluentibus distinctam et *D. carinatam,* Lindl. (Lindley, Gen. & Spec. Orchid. p. 510) labello unicarinato discernendam.

Osw. H. Sargent (Systematic Notes on Orchidaceæ, Journ. West Austr. Nat. Hist. Soc. p. 66, 1909) *D. setaceam* et *emarginatam* pro speciebus distinctis et formas intermedias pro hybridis habet. Sed annotationes cl. Sargenti optimum præbent testimonium formas has certis limitibus haud distinctas esse. Dicit enim: "*D. emarginata.* Closely resembles the last-named (i. e. *setacea* and *carinata*), but taller, stouter, and larger flowered. Leaves semiterete. Petals without spots, often emarginate. Middle lobe of labellum somewhat spreading. Both this species and *carinata* inhabit swampy places and flower in October. They often occur together, when intermediate forms, which I think must be hybrids, are found amongst them."

D. palachila a cl. R. S. Rogers in Trans. Roy. Soc. S. Austral. xxxi. (1907) p. 209 descripta et in tabula xxvi. delineata, quam cl. auctor *D. setaceæ* proxime affinem declarat, species sui juris et sat distincta esse videtur.

D. LONGIFOLIA, *R. Br.* (Bentham, vi. 331; Diels, Fragm. 118).

W. Australia: Bridgetown usque Kojonup et Slab Hut Gully, coll. A. A. Dorrien-Smith, 1909.

In monte Toolbrunup collegit cl. A. A. Dorrien-Smith formam *D. longifoliæ* gracilem primo aspectu a typo valde aberrantem, caulibus humilibus 1 dm. vel paulo plus altis unifloris vel bifloris, foliis angustis curvatis distinctam sed in typum specimine unico elatiori (ca. 25 cm. alto) trifloro abeuntem.

D. LONGIFOLIA, *R. Br.*, var. CORYMBOSA, *Domin*, comb. n. (*Lindl.* pro sp.).

W. Australia: Mallet; Slab Hut Gully usque Kojonup et Bridgetown, coll. A. A. Dorrien-Smith, 1909.

D. corymbosa (Lindley, Swan Riv. Append. 51, Gen. & Spec. Orch. 511), quam cl. Bentham cum *D. longifolia* junxit, certe est varietas sui juris, a var. *typica* floribus magnis, petalis latioribus etc. facile distinguenda.

MICROTIS, *R. Br.*

M. PORRIFOLIA, *Spreng.* (Bentham, vi. 347).

W. Australia: Cranbrook usque Warrungup, in planitie arenosa, coll. A. A. Dorrien-Smith, 1909, cum *Triglochine procera*, quæ cum ea in speciminibus siccatis mixta primo aspectu haud dissimilis apparet.

Eodem loco cl. A. A. Dorrien-Smith formam *M. porrifoliæ* collegit, quæ folio pro specie crasso stricte erecto racemum superante, racemo angusto laxo longiuscule acuminato notabilis est, sed florum structura a typo haud discrepat.

PTEROSTYLIS, *R. Br.*

P. NANA, *R. Br.* (Bentham, vi. 357).

W. Australia; Mt. Toolbrunup, coll. A. A. Dorrien-Smith, 1909.

Speciminibus *P. nanæ*, R. Br. et *P. pyramidalis*, Lindl. (Bentham, *l. c.*) copiosis examinatis et comparatis persuasum mihi habeo formam hanc tantum varietatem *P. nanæ* bracteis caulinis magis foliaceis insignem sistere. Alteram differentiam constantem eruere nequeo. *P. nana* var. *typica* foliis radicalibus rosulatis, caule scapiformi pro more graciliore et humiliore bracteaque unica vaginante instructo, *P. nana* var. *pyramidalis* statura robustiore, foliis minus conspicue rosulatis in bracteas caulinas haud ad vaginas reductas sed foliis similes sensim abeuntibus excellit, sed florum structura in specie utraque nulla nota majoris pretii discrepat. Bentham (*l. c.*), Diels (Fragm. 119), O. H. Sargent (Orchids occurring in York, Journ. West Austr. Nat. Hist. Soc. p. 11, 1906) et alii auctores *P. pyramidalem* pro specie sui juris habent, sed iam apud cl. Ferd. Mueller (Remarks on some Victorian Orchids, Wing's 'Southern Science Record,' September 1882) scriptum legimus: "Whether the West Australian *P. pyramidalis* is really distinct from *P. nana* seems very doubtful, inasmuch as its difference mainly rests on the expansion of the lower cauline bracts into leaves, transit forms occurring at Port Phillip in this respect."

Osw. H. Sargent, scribit *l. c.*: "Both these doubtfully distinct forms occur here: typical *nana* flowers in September; it usually occurs in moist sandy soils: a form with more or less rosulate leaves, but a stouter and more hairy plant, with larger flowers than typical *nana*; flowers in June, various soils: typical *pyramidalis* flowers in November; it grows in mud in the river-bed."

LYPERANTHUS, *R. Br.*

L. NIGRICANS, *R. Br.* (Bentham, vi. 364; Diels, Fragm. 120).

Forma *typica*: W. Australia: Slab Hut Creek usque Cranbrook, coll. A. A. Dorrien-Smith, 1909.

Forma PUMILA, caulibus pumilis tantum ca. 5 cm. altis bifloris insignis in monte Toolbrunup (leg. idem).

CALADENIA, *R. Br.*

C. MENZIESII, *R. Br.* (Bentham, vi. 379; Diels, Fragm. 121).

W. Australia: Yallingup et Cape Naturaliste, coll. A. A. Dorrien-Smith, 1909.

Forma valde elata, ca. 4 dm. alta, petalis sepalis haud multo longioribus, sed vidi quoque specimen unum gracilius typum speciei exhibens.

C. FILAMENTOSA, *R. Br.* (Bentham, vi. 381; Diels, Fragm. 121).

W. Australia: Bridgetown usque Kojonup et Slab Hut Gully, coll A. A. Dorrien-Smith, 1909.

Prope Mallet collegit cl. Dorrien-Smith formam sepalis petalisque lateralibus haud patentibus sed erectis insignem, quæ notis cæteris *C. filamentosam* bene quadrat.

C. FILAMENTOSA, *R. Br.*, var. CÆSAREA, *Domin*, var. n.

Gracilis sed elatior usque plus 30 cm. alta, foliis linearibus indumentoque cum typo congruens, caulibus unifloris vel bifloris, sepalis petalisque horizontaliter patentibus, labello majore ca. 14 mm. longo, parte sepalorum petalorumque inferiore subdilatata lutea nervis violaceo-brunneis percursa, labello intense luteo et prominule nervoso, nervis fusco-violaceis vel fere nigris.

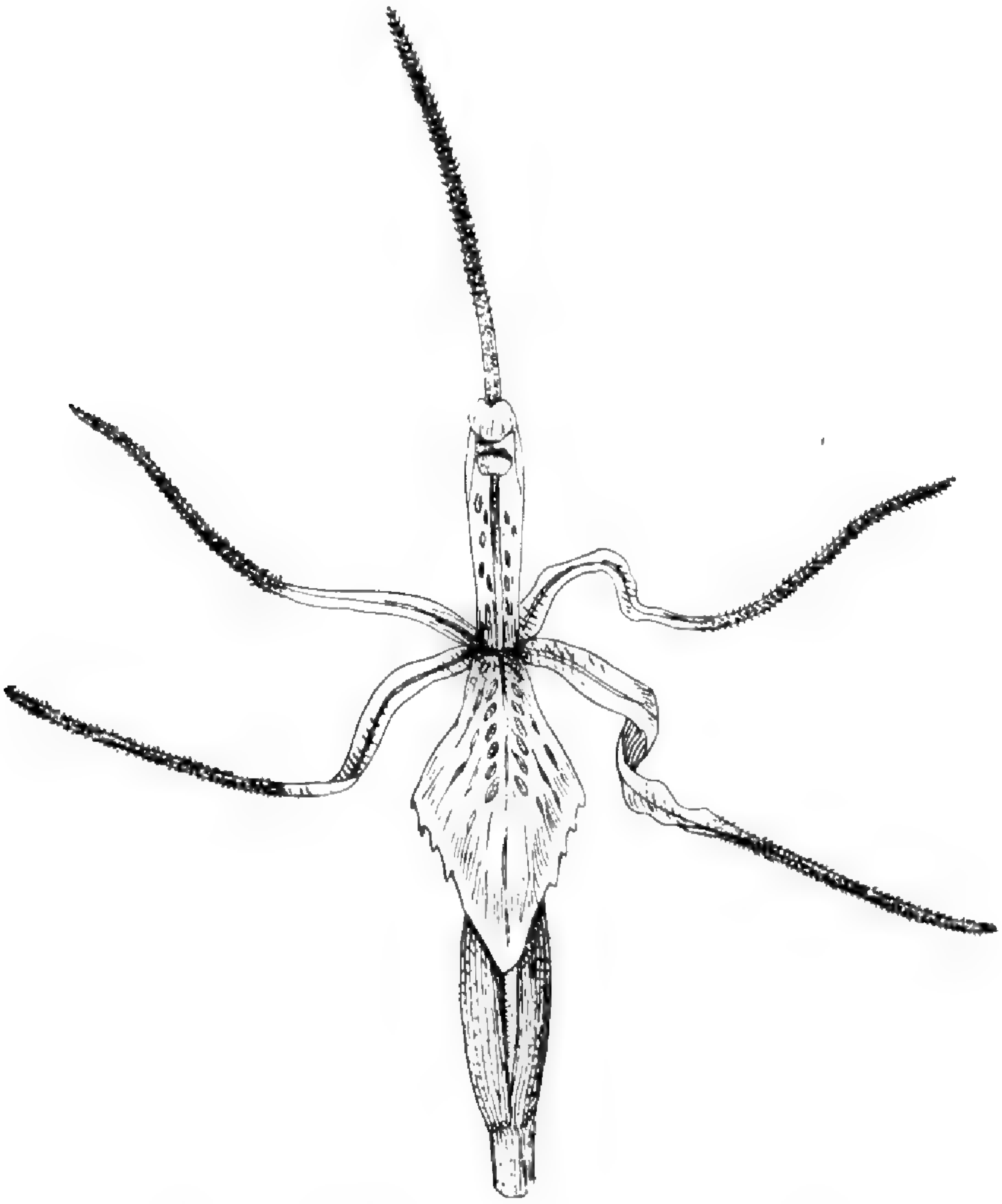
W. Australia: Bridgetown usque Kojonup et Slab Hut Gully, coll. A. A. Dorrien-Smith, 1909.

Varietas egregia, sed specifice haud diversa. *C. filamentosa* ex Diels (*l. c.*) perianthio nunc labello roseo purpureo-maculato saturate purpureo nunc labello albido callis purpureis ornato lurido ad apicem sepalorum purpurascente excellit.

CALADENIA DORRIENII, *Domin*, sp. n. (Text-fig., p. 252, and Plate **12**. fig. 23.)

Habitu staturaque *C. filamentosæ* similis eique affinis. Planta gracilis. *Caulis* semper uniflorus cum flore ca. 15 cm. altus pilis mollibus patentibus albis in caulis parte inferiore longissimis caulis diametro usque triplo longioribus, tractu superiore brevioribus villosus, basi vagina scariosa glabra brevi apice truncata instructus. *Folium basilare* unicum anguste lineare caule subæquilongum erecto-patens longissime albo-hirsutissimum ca. 3 mm. latum. Caulis nudus sed ad medium vel supra *bractea* lineari subpatente brevi instructus. *Flos* unicus terminalis pedunculatus basi vagina subscariosa amplectente ca. 10 mm. et ultra longa fulcratus. *Sepala petalaque* usque plus 2 cm. longa e basi anguste lanceolato-lineari trinervi tenui glabra usque 1 mm. lata filiformia, apice filiformi elongato fusco dense breviter glanduloso-villosa; *labellum* ca. 11 mm. longum et parte media, qua latissime patet, ca. 6 mm. latum, rhomboidale glaberrimum margine integro tantum lateraliter denticulis perpaucis obtusis instructum; *calli* glabri obtusi biseriati, serie utraque e callis 7–8 appropinquatis labelli medium attingentibus consistente; *ovarium* dense breviter glanduloso-villosum.

W. Australia: Bridgetown usque Kojonup et Slab Hut Gully, coll. A. A. Dorrien-Smith, 1909, in cuius honorem speciem hanc nominavi.



Flower of *Caladenia Dorrienii*, Domin, enlarged.

Species complures ex affinitate *C. filamentosæ* et *C. Patersoni* secundum specimina exsiccata vel descriptiones authenticas cl. R. A. Rolfe juvante comparavi, sed nulla cum planta nostra convenit itaque persuasum habeo *C. Dorrienii* typum novum adhuc ignotum sistere.

Sepala petalaque lateralia in plantis siccis crucis more recurvata sunt (Tab. **12**. fig. 23).

CALADENIA LONGICAUDA, *Lindl.*

W. Australia: Mallet; Yallingup et Cape Naturaliste, loco utroque, coll. A. A. Dorrien-Smith, 1909.

C. LONGICAUDA, *Lindl.*, var. EMINENS, *Domin*, var. n.

Perianthio usque 12 cm. longo; parte inferiore dilatata ca. 3 cm. longa niveo-alba.

Planta sæpe robusta, caulibus haud raro trifloris plus quam 4 dm. altis præcipue parte inferiore pilis mollibus longissimis patentibus hirsutissimis, folio oblongo-lineari molliter albo-hirsutissimo, pilis usque plus 1 cm. longis, labello albo lateraliter longe fimbriato.

Ad Mallet cum typo, leg. A. A. Dorrien-Smith.

Varietas primo aspectu a *C. longicaudæ* formis parvifloris toto cœlo abhorrens, sed occurrunt formæ intermediæ.

C. PATERSONI, *R. Br.* (sensu em.).

In Australia occidentali divulgata* formas numerosas limitibus certis haud distinctas exhibens, quarum una—*C. dilatata*, R. Br. (*C. Patersoni*, R. Br., var. *dilatata*, Benth. vi. 382)—in forma typica a *C. Patersoni* vera sat diversa, sed si specimina copiosa respicis, vix varietas propria esse videtur. Quæri potest, an *C. longicauda* species distincta sit. Me judice stirps hæc a cl. Lindley descripta, sed a cl. Bentham haud intellecta species sui juris erit. Specimina omnia facile a *C. Patersoni* formis diversis distinguere potui. Var. *eminens* supra descripta est stirps pulcherrima et nomen "Spider-Orchid" ad plantam hanc et omnes species affines adhibitum certissime varietatem nostram optime quadrat.

C. FLAVA, *R. Br.* (Bentham, vi. 384; Diels, Fragm. 121).

W. Australia: Yallingup et Cape Naturaliste, copiose, coll. A. A. Dorrien-Smith, 1909.

C. LATIFOLIA, *R. Br.* (Bentham, vi. 384).

Cum præcedente (coll. A. A. Dorrien-Smith).

C. REPTANS, *Lindl.* (Bentham, vi. 385; Diels, Fragm. 121).

W. Australia: Warrungup Hill, Stirling Range, coll. A. A. Dorrien-Smith, 1909.

C. SERRATA, *Rchb. f.* (Bentham, vi. 386; Diels, Fragm. 122). (=*Lyperanthus serratus*, Lindl.)

W. Australia: Bridgetown usque Kojonup et Slab Hut Gully, coll. A. A. Dorrien-Smith, 1909.

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* Yallingup and Cape Naturaliste; Bridgetown to Kojonup and Slab Hut Gully; Mt. Toolbrunup; Mallet, locis omnibus coll. A. A. Dorrien-Smith. Magnitudo florum valde variabilis (4-10 cm.), sed formæ parvifloræ et grandifloræ vix pro varietatibus salutandæ.

CALADENIA GEMMATA, *Lindl.* (Bentham, vi. 389 ; Diels, Fragm. 122).

W. Australia : Yallingup et Cape Naturaliste; Mallet, coll. A. A. Dorrien-Smith, 1909.

GLOSSODIA, *R. Br.*

G. BRUNONIS, *Endl.* (Bentham, vi. 393).

W. Australia : Yallingup et Cape Naturaliste, coll. A. A. Dorrien-Smith, 1909.

G. EMARGINATA, *Lindl.* (Bentham, vi. 393 ; Diels, Fragm. 122).

W. Australia · Bridgetown usque Kojonup et Slab Hut Gully, coll. A. A. Dorrien-Smith, 1909.

Species quoad perianthium variabilis. Præter formam typicam tepalis minoribus angustioribusque insignem vidi specimina tepalis multo majoribus et præcipue latioribus conspicua, sed si forte formæ grandifloræ primo aspectu diversæ sed cum typo promiscue crescentes varietatem propriam sistant dijudicare non audeo.

IRIDACEÆ.

PATERSONIA, *R. Br.*

P. OCCIDENTALIS, *R. Br.*, var. ÆMULANS, *Domin*, var. n. Scapis foliis sublongioribus, foliis pro specie brevibus angustis 2½ usque 3¼ mm. latis.

W. Australia : Slab Hut Gully usque Cranbrook, coll. A. A. Dorrien-Smith, 1909.

Varietas insignis, habitu *P. longiscapam* Australiæ orientalis incolam æmulans, sed cæterum ad *P. occidentalem* referenda. Quæri potest, anne duæ illæ formæ unius ejusdemque speciei varietates sint. *P. occidentalis* species est admodum variabilis formas numerosas varietatesque distinctas (var. *latifolia*, Benth. vi. 403, var. *eriostephana* (Muell. spec.) etc.) amplectens, quarum plures amplius sunt investigandæ. Formæ plurimæ a cl. Endlicher in ‘ Plantæ Preissianæ,’ vol. ii. pp. 30–31, pro speciebus distinctis descriptæ et in vicinitatem *P. occidentalis* spectantes (*P. tenuispatha*, *turfosa*, *Diesingii*, *nana*, *compar*, *flaccida*, *sylvestris*, *montana*) valde sunt dubiæ et ob descriptiones incompletas sine specimina authentica haud sunt eruendæ.

Varietatis *æmulantis* folia longissima longitudinem 16 cm. attingunt, sed plura sunt breviora et omnia scapis breviora.

P. UMBROSA, *Endl.*, var. XANTHINA, *Oldf. et F. Muell.* (Benth. vi. 404, pro sp.).

W. Australia : Yallingup et Cape Naturaliste, coll. A. A. Dorrien-Smith, 1909.

Planta rarissima, florum colore insignis sed cæterum ab affini *P. umbrosa*, Endl., quæ floribus cæruleis gaudet, parum diversa et vix species propria esse videtur.

MORÆA, *L.*

MORÆA sp.

W. Australia: Slab Hut Gully usque Cranbrook, coll. A. A. Dorrien-Smith, 1909.

Plantæ introducta, species verosimiliter austro-africana.

ORTHROSANTHUS, *Sweet.*

O. LAXUS, *Benth.* (Bentham, vi. 411). (=*Libertia laxa*, Endl.)

W. Australia: Yallingup et Cape Naturaliste, coll. A. A. Dorrien-Smith, 1909.

Planta perennis rhizomate horizontaliter elongato lignoso stolonibusque subterraneis crassis directis bracteis (*i. e.* foliis ad vaginas reductis) numerosis scariosis instructis prædita.

O. POLYSTACHYUS, *Benth.* (Bentham, vi. 411).

In Australia occidentali cum præcedente collegit cl. Dorrien-Smith.

AMARYLLIDACEÆ.

TRIBONANTHES, *Endl.*

T. UNIFLORA, *Lindl.* (Bentham, vi. 427; Diels, Fragm. 107).

W. Australia: Bridgetown usque Kojonup et Slab Hut Gully, coll. A. A. Dorrien-Smith, 1909.

CONOSTYLIS, *R. Br.*

C. ACULEATA, *R. Br.*, var. ABBREVIATA, *Domin*, var. n. Excellit caule abbreviato crasso, foliis distichis linearibus rigidissimis flexuosis glabris usque 3 dm. longis et 4–4¼ mm. latis cartilagineo-marginatis (sed margine haud prominulo), margine aculeis (setis) erecto-patentibus distantibus armatis, scapo brevissimo valde ramoso, ramis bracteis late ovatis brunneis suffultis, floribus cymoso-corymbosis, perianthio ca. 12–13 mm. longo, antheris linearibus ca. 4 mm. longis.

W, Australia: Mallet, coll. A. A. Dorrien-Smith, 1909.

Varietas breviscapa egregia sed vix species propria. *C. aculeata*, R. Br., species est admodum variabilis, formas primo aspectu diversissimas sed formis intermediis conjunctas exhibens. *C. filifolia*, F. Muell. et *C. phathyrantha* Diels (foliis glabris et setis nullis excellentes) necnon *C. spinuligera*, F. Muell foliis perangustis conspicua, species sunt sui juris ab omnibus *C. aculeatæ* formis sat diversæ. *C. bromelioides*, Endl. (Bentham, vi. 438; Diels, Fragm. 111) attamen me judice a *C. aculeata* specifice non est separanda, etsi in forma typica diversissima appareat.

C. aculeata, R. Br. var. *typica* (R. Brown, Prodr. 300, vidi specimina authentica, No. 5625 !) foliis longioribus et latioribus, setis multo gracilioribus patento-erectis, margine foliorum cartilagineo tenuiore et minus prominente, scapis elongatis, inflorescentia valde composita multiflora, perianthio minore et profundius partito, bracteis angustioribus insignis est et in Australia occidentali stationibus numerosis occurrit.

C. aculeata, R. Br. var. *bromelioides*, Domin, var. n., est planta minus copiosa et adhuc e stationibus paucis nota. Vidi specimina Drummondiana (Swan River, No. 26) et Pritzeliana (in distr. Avon, in arenosis pr. Tammin, E. Pritzel, No. 828), utraque robusta, foliis planis magnis rigidis conspicue cartilagineo-marginatis et setis rigidis pungentibus armatis instructa et tantum antherarum forma parum diversa. In plantis Pritzelianis antheræ lineares, elongatæ, in plantis Drummondianis breviores sunt.

Plantæ a cl. Max Koch in Australia occidentali sub No. 1471, 1472 (prope Wooroloo) et No. 1320 (prope Watheroo) collectæ et in schedis ut *C. bromelioides* designatæ *C. aculeatæ* var. *typicæ* propius accedunt, quamvis specimina pauca (præcipue sub No. 1320) spinis rigidis subpatentibus pungentibus et nervo marginali cartilagineo prominente insignes sint. Omnes attamen floribus minoribus, pro more vix vel paulum plus 12 mm. longis gaudent.

CONOSTYLIS PSYLLIUM, *Endl.* (Bentham, vi. 433).

W. Australia : Bridgetown usque Kojonup et Slab Hut Gully, coll. A. A. Dorrien-Smith, 1909.

ANIGOZANTHOS, *Labill.*

ANIGOZANTHOS DORRIENII, *Domin*, sp. n. (Sectio *Haplanthesis*, Benth. vi. 442.)

Perennis, rhizomate brevi crasso. *Caulis* cum racemo vix 3 dm. altus totus undique lanugine albo-flavescente obtectus, tantum ad basin foliatus, cæterum bracteas paucas (2–3) distantes gerens, bractea suprema racemo approximata. *Folia* infima curvatim patentia brevia plus minusve conduplicata ca. 4–4½ mm. lata et cum vaginis plus 10 cm. longa adulta glabra et tantum ad margines et carinam pilis plumosis sparsis vestita ; *vaginæ* glabræ parte inferiore membranaceæ et pallidæ (nec virides) et tantum violaceo-nervosæ. *Flores* speciosi subsessiles in racemos subdensos terminales unilaterales (prima juventute apice subsecundos) simplices usque 8 cm. longos et circiter 15-floros dispositi ; racemi caulium lateralium sæpe conspicue breviores et interdum tantum 8-flori ; *pedunculus* floris infimi ca. 5 mm. longus ; flores omnino lanugine plumosa flavo-lutescente dense obtecti ca. 34–37 mm. longi recti vel parum curvati æqualiter tubulosi in sicco ca. 5–6 mm. lati. *Perianthii* lobi anguste falcato-lanceolati intus subglabri flavidi

4–5 mm. longi; perianthii tubus parte inferiore fere ad basin fissus intus plus minusve fusce coloratus. *Antheræ* filamentis filiformibus æquilongæ ca. 2½ mm. longæ, appendicibus nullis.

W. Australia: Cranbrook usque Warrungup, in planitiebus arenosis, coll. A. A. Smith-Dorrien, cui speciem hanc pulchram dedico.

A. Dorrienii ex omnibus sectionis *Haplanthesis* speciebus *A. humili* proxime accedit, sed ab hoc primo aspectu florum colore et præterea characteribus supra indicatis facile dignoscitur. *A. humilis* gaudet floribus viridibus vel flavescentibus sed conspicue coccineo suffusis et tantum rarissime variat floribus flavissimis (*cf.* Diels, Fragm. 113).

A. HUMILIS, *Lindl.* (Bentham, vi. 444; Diels, Fragm. 113).

W. Australia: Bridgetown usque Kojonup et Slab Hut Gully, coll. A. A. Dorrien-Smith, 1910.

A. MANGLESII, *D. Don*, var. LEPTOPHYLLA, *Domin*, var. n. Foliis radicalibus abbreviatis vix 10 cm. longis et multo angustioribus tantum ca. 2–3 mm. latis.

Cum præcedente coll. A. A. Dorrien-Smith.

Varietas foliis a typo valde discrepans, sed scapis (plus 3 dm. altis), racemo necnon florum magnitudine, structura et colore haud diversa.

ANIGOZANTHOS GABRIELÆ, *Domin*, sp. n. (Sectio *Haplanthesis*, Benth. vi. *l. c.*) (Plate **12.** fig. 22.)

A. bicolori proxime affinis; excellit statura gracili humilique; specimina nostra copiosa habent caules numerosos cæspitosos, radicem fibrosam, innovationes nullas itaque plantas annuas quam maxime æmulant. *Caules* graciles subnudi ca. 1 dm. alti foliis plus quam duplo longiores tractu superiore lanugine plumosa subpatente detersili coccinea (interdum viridi suffusa) obtecti. *Folia* glauca numerosa omnia subradicalia erecta brevia cum vaginis 3–5½ cm. longa glabra vel fere glabra 1 mm. vel raro usque 2 mm. lata. *Racemi* terminales unilaterales breves usque 8-flori sed haud raro ad flores perpaucos approximatos reducti, racemi rhachis dense coccineo-lanuginosa; *pedunculi* 3–4 mm. longi coccinei. *Flores* speciosi sed quam in *A. bicolori* multo minores 2½–3 cm. longi conspicue curvati basi (ovario) densissime coccineo-lanuginosi cæterum lanugine fere smaragdineo-viridi vestiti. *Perianthii* tubus lageniformis *i. e.* e basi latiore apicem versus valde angustatus et rursum in limbum latiorem oblique ovatum dilatatus, perianthii lobi breves lanceolati 2–4 mm. longi intus pallide oleagino-virides. *Stamina* biseriata, 4 multo superius et 2 infra inserta; *antheræ* ca. 1¼–1½ mm. longæ filamentis subæquilongæ vel præsertim in serie inferiore iis plus minusve interdum conspicue breviores. *Ovula* in utroque loculo numerosa.

W. Australia : Cranbrook usque Warrungup, ubi cum *A. Dorrienii* planities arenosas adornat ; coll. A. A. Dorrien-Smith, 1910.

Species egregia *A. bicolori* proxime affinis sed ab omnibus hujus speciei formis, etiam a varietate *minori*, Benth. sat diversa. Dixi in honorem dominæ *Gabrielæ* Domin, uxoris meæ, quæ sæpe me in studiis botanicis labore assiduo adjuverat.

Omnes generis *Anigozanthi* species adhuc descriptæ perennes sunt et rhizoma conspicuum habent. *A. Gabrielæ* unica annua esse videtur sed forsitan est forma primo anno florens speciei perennis, sed nullas innovationes nec gemmas quiescentes emmittens.

LILIACEÆ.

DIANELLA, *Lam.*

D. REVOLUTA, *R. Br.* (Bentham, vii. 15 ; Diels, Fragm. 98).

W. Australia : Warrungup Hill, Stirling Range, coll. A. A. Dorrien-Smith, 1909, forma valde robusta.

BURCHARDIA, *R. Br.*

B. UMBELLATA, *R. Br.* (Bentham, vii. 33 ; Diels, Fragm. 98).

Species quam maxime variabilis sed speciminibus omnibus herbarii Kewensis examinatis vix naturale mihi videtur formas primo aspectu diversissimas pro speciebus distinctis agnoscere, nam multæ exstant formæ inter "species" has vacillantes. *B. umbellata* per Australiam occidentalem divulgata esse videtur et in stationibus diversis et diverso anni tempore formas miras profert, quarum nonnullæ ut species propriæ descriptæ sunt, sed me judice tantum varietates exhibent. Cl. J. Lindley ("A Sketch of the Vegetation of the Swan River Colony," Botan. Reg. xxiii. App. 1839, p. 58), præter *B. umbellatam* a cl. R. Brown descriptam duas species novas describit, i. e. *B. multifloram*, Lindl. (foliis scapi basi cucullatis, umbella 20-flora, pedicellis periphericis horizontalibus) et *B. congestam*, Lindl. (foliis scapi basi simplicibus, radicali longissimo lineari, umbella pauciflora congesta, pedicellis florum longitudine).

Cl. St. Endlicher (Plantæ Preissianæ, vol. ii. (1846–1847, p. 44) omnes 3 species accepit, sed cl. Bentham eas sub specie una rursum conjunxit. Cl. Diels (*l. c.*) affirmat *B. multifloram*, Lindl. et *B. congestam*, Lindl. per Australiam occidentalem fere semper facillime discriminari posse. "*B. multiflora* elatior gracilis locorum minus humidorum glareosorum indigena flores posterius gignit, *B. congesta* præcox robusta locos uberiores hieme humidos adornat."

B. umbellatæ formæ me judice, ut sequitur, partiri possunt :—

α. *Foliis caulinis basi (vagina) manifeste dilatatis*, supremis vel bracteis ad vaginas latas reductis, pedicellis plerumque elongatis.

1. Var. MULTIFLORA, *Domin*, comb. n. (=*Burchardia multiflora*, Lindl. *l. c.*, Endl. *l. c.*)

Valde elata, sæpe plus 3 dm. alta, umbellis multifloris, pedicellis ca. 3–5 cm. longis.

Formam typicam 20-floram non vidi, sed plantæ a cl. Drummond (Swan River, No. 1843) collectæ descriptionem varietatis hujus notis plurimis bene quadrant.

2. Var. ORNITHOGALOIDES, *Domin*, var. n. Varietati præcedenti affinis, sed excellit statura multo humiliore, caule florente raro usque 2 dm. alto, floribus in umbella haud numerosis (usque 7).

Var. *typica* (vide sub no. 4) differt foliis basi vix dilatatis, bracteis sub umbella conspicue majoribus, pedicellis strictis rigidioribus 2–3 cm. longis.

Var. *ornithogaloides* mihi e stationibus pluribus nota, *e. g.* :

(*a*) District Swan : in silvis subumbrosis montium Darling Range, coll. E. Pritzel, Julio 1901 (Exsic. Austr. No. 454).

(*b*) Inter Perth et Coolgardie, coll. G. H. Thiselton-Dyer, 1903, No. 2 Pumping Station, Mundaring.

Varietas nostra haud raro pro *B. multiflora* determinatur.

3. Var. STRICTIFLORA, *Domin*, var. n. Varietati præcedenti similis, statura humili, umbella pauciflora, pedicellis strictis rigidiusculis erecto-patentibus elongatis circiter 5 cm. usque plus 6 cm. longis excellens.

Habitat in Australia occidentali locis pluribus, *e. g.* :

(*a*) Bridgetown usque Kojonup et Slab Hut Gully, coll. A. A. Dorrien-Smith, 1909.

Specimen unum ex axilla folii supremi scapum uniflorum 9 cm. longum et 3 bracteas lineares parvulas gerentem emmittit.

(*b*) Yallingup et Cape Naturaliste, legit idem.

(*c*) Stirling Range, collegit Oldfield.

(*d*) Vape River, coll. Mrs. Molloy.

β. *Foliis caulinis basi haud manifeste dilatatis*, sed basi plus minusve amplectente vix latiore insertis.

4. Var. TYPICA, *Domin*. (=*B. umbellata*, R. Br., sensu str. (vidi specimen authenticum Brownianum, sub no. 5675).

Valde elata, foliis angustis elongatis, floribus in umbella haud numerosis, pedicellis floribus non multo (raro usque duplo) longioribus gracilibus haud strictis, bracteis parvis.

W Australia : Yallingup et Cape Naturaliste, coll. A. A. Dorrien-Smith, 1909.

B. umbellata, R. Br. var. *gracilis,* Cec. Andrews, Flora of W. Austr. 1st coll. No. 986 est teste speciminis authentici (Claremont prope Perth, in arenosis aridis, 21 Septembre, 1902) forma grandiflora a var. *typica* nullo modo diversa.

B. congesta, Lindl. est ex descriptione forma varietatis *typicæ,* sed non varietas propria.

Occurrit forma *minor,* caulibus humilioribus, foliis brevioribus et interdum latioribus.

Adhuc imperfecte nota est

5. Var. COMPOSITA, *Domin,* var. n.

Valde elata, parte superiore ramosa, ramis lateralibus e sinu bractearum egredientibus elongatis umbellas minores gerentibus, umbellis 5–8-floris, pedicellis haud strictis sed floribus interdum plus quam duplo longioribus, perigonio roseo.

W. Australia : in locis madidis prope ostium fl. Murchison, coll. Oldfield.

Varietas notabilis sed plantæ imperfecte collectæ parte inferiore foliisque destitutæ. Planta verosimiliter valde exaltata (certe plus 5 dm. alta) fuit, nam pars suprema sola longitudinem plus 3 dm. attingit.

BURCHARDIA MONANTHA, *Domin,* sp. n.

Radix fibrosa, fibris numerosis fasciculatis plus minusve incrassatis tuberiformibus (sed bulbo nullo). *Caulis* parte infima tractu usque 5 cm. longo vaginis elongatis vetustis brunneis numerosis plus minusve dilaceratis involucratus scapiformis gracilis glaber stricte erectus simplicissimus ca. 20–25 cm. altus nudus, *i.e.* ad tertiam partem inferiorem bractea unica ad vaginam clausam brevem laxe amplectentem apice oblique truncatam reducta et circiter 4½–6 cm. sub flore unico terminali bracteis duabus minutis ca. ¾ cm. longis anguste oblongo-linearibus planis basi angustata insertis nunc suboppositis nunc parum distantibus instructus. *Folium* radicale unicum elongatum lineare sed perangustum glabrum molle convolutum et circiter ½ mm. latum rarius subplanum caulem ferme adæquans. *Flos* terminalis erectus semper solitarius speciosus. *Perianthii* segmenta 6 subæqualia libera ovato-elliptica acuta basi brevissime unguiculata circiter 11–12 mm. longa et 4–5¾ mm. lata demum decidua alba vel in sicco rosea subpatentia. *Antheræ* 6 peltatæ lineares ca. 4–4½ mm. longæ. *Styli* 3 basi breviter coaliti cæterum liberi.

W. Australia : Bridgetown usque Kojonup et Slab Hut Gully, coll. A. A. Dorrien-Smith, 1909.

Species floribus solitariis terminalibus notabilis, sed a *Burchardia*, cujus species adhuc nota unica australiensis floribus umbellatis insignis est, generice haud diversa.

Bulbine, *L.*

B. semibarbata, *Haw.* (Bentham, vii. 35 ; Diels, Fragm. 98).

W. Australia: Cranbrook usque Warrungup, in arenosis, coll. A. A. Dorrien-Smith, 1909.

Forma *gracilescens*, circiter 2 dm. alta, foliis linearibus brevibus angustis, capsulis parvis diametro ca. 3 mm.

Forma hæc respondet speciminibus quæ a cl. R. Brown sub no. 5675 collecta vidimus.

Thysanotus, *R. Br.*

Th. triandrus, *R. Br.* (Bentham, vii. 39).

Species hæc speciminibus numerosissimis examinatis admodum variabilis nobis videtur sed cum characteres differentiæque in florum structura minoris sint pretii aut sub exsiccatione evanescant, difficile in varietates et formas dividitur. Generis *Thysanoti* species multas ulterius scrutare et formas varias in natura observare necesse erit, quod plantæ vivæ sæpius toto cœlo diversæ apparentur, sed in exsiccatis ægre vel vix distingui possunt. De duratione et formarum speciei hujus vita, quæ quoad explicationem affinitatum naturalium maximi sunt pretii, nihil cognovimus.

Species hac ab auctoribus perennis indicatur, sed formæ variæ quoad innovationes et habitum diversissimæ sunt. Plantæ sub varietate *præcoci* descriptæ et arenosorum incolæ cæspites simplices fasciculatos efformant et cum innovationes desint et radix fibrosa adsit, primo aspectu sine ullo dubio annuæ apparentur.

Vita attamen plantarum multarum in arenosis siccis Australiæ subtropicæ vigentium re vero mirabilis et adhuc non explicata est. Plantæ hæ primo anno florentes fructusque producentes consensu generali pro annuis salutantur. Sed multæ sunt regiones, in quibus plantarum vegetatio nullo anni tempore omnino interrupta est, aut aliæ, in quibus plantarum evolutio aliquantum pluvia frequente respondet, ita ut modo planta primo anno florens ut annua emoriatur, modo iterum (conditionibus prosperioribus) porro crescat et in formam biennem aut perennem abeat et eodem tempore habitum et characterem commutet.

E tota formarum serie, quarum multas pro varietatibus meris salutare diu hesitavi, sequentes notabiles mihi videntur :

1. Var. typicus, *Domin.*

Perennis, dense cæspitosus, cæspitum basi indurata, scapis plerumque ca. 2 dm altis foliis pro more dimidio longioribus rarius ea adæquantibus, floribus in umbella plerumque numerosis, bracteis brevibus.

In Australia occidentali locis pluribus, collegit Drummond (Swan River, No. 1839), Oldfield (Mt. Barker, sub no. 671) et alii.

Præcipue specimina a cl. Oldfield collecta typum speciei exhibent et cum figura Labillardieri (tab. 110) optime conveniunt. Folia sunt interdum scapis longiora et pedicelli supra bracteas articulati.

2. Var. HISPIDULUS (*R. Br.*), *Domin*, var. n. (= *Th. hispidulus*, R. Br. Prodr. 285; Baker, Journ. Linn. Soc., Bot. xv. (1877) p. 341. *Th. nanus*, Endl. in Pl. Preiss. vol. ii. p. 38.)

Differt a typo præcipue umbellis paucifloris (3–4-floris).

Cl. Baker (*l. c.* p. 341) *Th. hispidulum* in hunc modum describit:—"Dense cæspitosus, fibris radicalibus tenuibus haud tubiferis. Folia radicalia stricta erecta 2–3 poll. longa subulata $\frac{1}{2}$ lin. lata pilis brevibus albidis hispidis patulis ubique vestita. Scapus simplex 1–4 poll. longus. Umbellæ solitariæ terminales 3–4 floræ, bracteis lanceolatis 2–3 lin. longis, pedicellis bracteis brevioribus medio articulatis. Perianthium $4\frac{1}{2}$–5 lin. longum. Stamina 3, antheris æqualibus."

Var. *hispidulus* in diversis Australiæ occidentalis stationibus reperitur. *Th. nanus* Endl. (*l. c.* p. 38), qui præter alia "pedicellis articulo inferiore brevissimo, superiore bracteas acuminatas vix æquante" insignis indicatur, forma var. *hispiduli* juvenilis (floribus nondum evolutis) esse videtur, cæterum haud diversa. Folia *Th. nani* a cl. Endlicher obtusa, illa *Th. triandri* acuta esse dicuntur, sed vidi folia speciminis anthentici, quæ nullo modo discrepant

3. Var. PRÆCOX, *Domin*, var. n.

Annuus esse videtur; dense fasciculato-cæspitosus, radice fibrosa tenui, vaginis fere totis scariosis, foliis numerosissimis ca. 1 dm. longis tenuibus pilis albidis patentibus ciliato-setosis, scapis gracilibus valde complanatis, bracteis pro dimensione longis (usque plus 1 cm. longis) violaceo-coloratis longe acuminatis, floribus in umbella sat numerosis (circiter 5–8), parte pedicellorum inferiore ante anthesin brevissima.

W. Australia: Bridgetown usque Kojonup et Slab Hut Gully, coll. A. A. Dorrien-Smith, 1910.

Habitu a *Th. triandro* toto cœlo diversus et annuus esse videtur. Florum pedicelli bracteis manifeste sunt breviores, sed verosimiliter pedicelli et pericladium in floribus perfecte evolutis magis extenduntur. Plantæ nostræ habent florum gemmas valde progressas sed nondum apertas.

4. Var. BENTIANUS, *Domin*, var. n. (= *Th. Bentianus*, A. T. Ewart et T. White in Proc. Roy. Soc. Vict. xxi. (1909) p. 546.)

W. Australia: Youndegin, coll. Alice Eaton, 1893.

E descriptione originali *Th. Bentianus* varietas speciei nostræ polymorphæ esse videtur. Cum varietate præcedente convenit statura humili, excellit foliis densius setosis, setis crassioribus rigidioribus longioribusque, scapis foliis dimidio longioribus, umbella terminali interdum umbella minore laterali suffulta, perianthio conspicue minore.

5. Var. PRITZELIANUS, *Domin*, var. n.

More varietatis typicæ cæspitosus, sed rigidior, foliis rigidis brevibus circiter 5–6 cm. raro nonnullis usque 10 cm. longis, scapis robustis crassis rigidisque haud complanatis 12–14 cm. altis foliis manifeste longioribus, umbellæ radiorum basi communi crassa, umbellis multifloris, bracteis numerosissimis sat longis coloratis, pedicellorum parte inferiore brevi bracteis multo breviore, pericladio usque 9 mm. longo, perianthio ca. 11 mm. longo ; umbella terminali interdum umbella minore laterali superata.

W. Australia : Distr. Avon : in arenosis apertis, coll. E. Pritzel, Septembre 1901 (Pritzel, Exsicc. Austr. No. 833).

Varietas a typo speciei valde diversa, foliis rigidis, scapis crassis haud complanatis præter alia excellens.

6. Var. TUNICATUS, *Domin*, var. n.

Perennis, dense cæspitosus, rhizomate et caule basi tuberoso-incrassato sublignoso duro vaginis vetustis marcescentibus et partim in fila brunnea dissolutis dense obtecto, foliis robustis 19–22 cm. longis scapos adæquantibus vel iis paulo longioribus planis vel marginibus subinvolutis usque 2 mm. latis, scapis robustis vix complanatis, umbella solitaria terminali, bracteis brevibus plurimis circiter 5 mm. longis, floribus numerosissimis (usque plus 30 in umbella) longepedicellatis, pedicellis fere 15 mm. longis circiter medio articulatis et articulatione demum rumpentibus, perianthio ca. 10½–12 mm. longo.

W. Australia : prope Perth locis pluribus collegit Cecil Andrews, *e. g.* pr. Bellevue ("Ironstone gravel," exeunte Septembre 1901, Exsicc. Fl. of W. Austr. 1st collect. No. 991) et pr. Claremont (in arenosis, Octobre 1902).

Formam var. *tunicatæ* minus typicam (foliis dorso plus convexis subcanaliculatis) a cl. Max Koch prope Woorooloo (Exsicc. Fl. of W. Austr. No. 1777) m. Novembre collectam vidimus.

CHAMÆSCILLA, *F. Muell.*

CH. CORYMBOSA, *F. Muell.* (Bentham, vii. 48).

W. Australia : Warrungup Hill, Stirling Range (forma parvula) et prope Mallet, loco utroque collegit A. A. Dorrien-Smith, 1909.

CH. CORYMBOSA, *F. Muell.*, var. VERSICOLOR, *Domin*, var. n. (? *Cæsia versicolor*, Lindl. Swan River, App. 57 ; Endl. in Pl. Preiss. ii. 34.)

Planta elata plus 3 dm. alta, scapis foliis duplo longioribus, inflorescentia magna composita, floribus plerumque majoribus plus 8 mm. longis.

W. Australia : Swan River, leg. Drummond, 1839.

Varietas nostra est verosimiliter cum *Cæsia versicolore* Lindl. e districto Swan River descripta identica. Cl. Lindley speciem suam "foliis radicalibus oblongis striatis scapo corymboso-paniculato brevioribus, floribus erectis" describit. Cl. Endlicher (*l. c.* p. 34) *Cæsiam versicolorem* pro specie enumerat, quærit attamen: "An satis a *C. corymbosa* R. Br. differt?" Cl. Bentham (*l. c.*) *C. versicolorem* cum specie hæc conjuxit, sed me judice *C. versicolor* varietatem distinctam sistit, quæ etiam fibris caulis basem obtegentibus insignis est.

Var. *versicolor* (cujus nomen haud est idoneum) distr. Swan River stationibus diversis pervadere videtur. Vidi e. g. specimina a cl. E. Pritzel in silvis subumbrosis montium Darling in Septembre 1901 collecta et sub no. 297 edita.

CHAMÆSCILLA SPIRALIS, *F. Muell.* (Bentham, vii. 48). (Plate **13**. fig. 24.)

W. Australia : Slab Hut Gully usque Cranbrook, collegit A. A. Dorrien-Smith, 1909.

Planta a *Ch. corymbosa* specifice diversa, vaginis vetustis in fila solutis, foliis et inflorescentiæ forma facile dignoscenda.

CH. PARADOXA, *Domin*, comb. n. (*Cæsia? paradoxa*, Endl. in Pl. Preiss. ii. p. 34; Baker, Journ. Linn. Soc., Bot. xv. (1877) p. 331.)

Species a *Ch. spirali* omnino diversa, in Australia occidentali rarissime nascens.

CHAMÆSCILLA DYERI, *Domin*, sp. n.

Scapi 15 cm. vel fere 20 cm. alti glabri stricti inflorescentia breviores vel ei subæquilongi. *Inflorescentia* paniculato-racemosa, *i. e.* e racemo elongato terminali simplici et racemis pluribus lateralibus remotiusculis brevioribus consistens; *racemus terminalis* sæpe plus 15 cm. longus; *pedicelli* stricti sed graciles divaricati elongati circiter 15 mm. usque 20 mm. longi bracteis parvis suffulti. *Flores* ca. 5–10 mm. ab invicem distantes. *Perianthium* circiter 10 mm. longum cæruleum. *Capsula* juvenilis trilocularis, seminibus in loculo utroque pluribus.

W. Australia : prope viam ferream inter Cunderdin et Dedari, collegit cl. Thiselton-Dyer, m. Octob. 1903 (Exsicc. : between Perth and Coolgardie, 164).

Species inflorescentiæ formæ, pedicellis divaricatis strictis elongatis distinctissima sed ob folia ignota ulterius observanda. Habitu quodam modo *Arthropodium capillipes*, Endl. revocat.

STYPANDRA, *R. Br.*

S. GLAUCA, *R. Br.*, var. PROPINQUA, *Baker*, Journ. Linn. Soc., Bot. xv. (1877) p. 356. (=*S. propinqua*, A. Cunn. in Bot. Mag. tab. 3417. *S. virgata*, Endl. in Pl. Preiss. vol. ii. p. 35.)

W. Australia : prope Mallet coll. A. A. Dorrien-Smith, 1909.

JOHNSONIA, *R. Br.*

Jam cl. J. G. Baker in Journ. Linn. Soc., Bot. xvii. (1879) (A Synopsis of Colchicaceæ and the Aberrant Tribes of Liliaceæ) p. 417 usque 419 genus *Johnsoniam* in Australiæ occidentali endemicum et ibi species perpaucas exhibens accurate perscrutavit, sed speciminibus numerosis præcipue tempore recente collectis examinatis *J. pubescentem* et *acaulem* specifice differe agnoscere nequeo.

J. lupulina R. Br. (Bentham, vii. 68) sine ullo dubio species est sui juris, quæ scapis robustis valde exaltatis, foliis longis latioribus distichis, bracteis elongatis angustioribus, inferioribus numerosis sterilibus (nec floriferis) necnon glabritie insignis est et facillime distinguitur.

Omnes aliæ generis *Johnsoniæ* formæ me judice tantum varietates vel formas speciei unicæ polymorphæ, *J. pubescentis* Lindl. s. em., constituunt, nam limites certi inter eas trahi non possunt.

Etiam cl. Ferd. Mueller (Fragm. Phyt. Austr. vol. vii (1869–1871) p. 87) præter *J. lupulinam* speciem unicam accipit, quam *J. hirtam*, Lindl., nominat. *J. hirta* est secundum cl. Mueller, "humilior, minor, varie pubescens vel fere glabra, bracteis ciliolatis, perpaucis inferiorum vel vix ullis vacuis, calycibus persistentibus, seminibus parvis ellipsoideis passim ovatis."

"Varietas filifolia producit scapum cum foliis teretiusculum."

"Varietas acaulis, tam glabra quam pubescens, scapum habet brevem vel brevissimum et gignitur in humo glareoso (*e. g.* ante Stirling's Range), ubi statu nano jam præcociter florescit. Ita primo anno tantum fibræ radicis nondumque rhizoma evolvuntur."

J. PUBESCENS, *Lindl.*, Swan River App. 57, *sensu ampl.*

Dividitur in varietates sequentes:—

1. Var. TYPICA, *Domin.*

Scapo producto pro more 1 dm. et ultra alto.

Variat foliis glabris et hirsutis.

α. f. GLABRA, *Domin*, f. n. (=*J. pubescens* (typ.), Baker, *l. c.* p. 418.)

β. f. HIRTA, *Domin*, f. n. (= *J. hirta*, Lindl. Swan Riv., App. 57. *J. pubescens* var. *hirta*, Baker, *l. c.* p. 419. *J. longifolia*, Endl. in Pl. Preiss. vol. ii. p. 40. *J. mucronata*, Endl. *l. c.* p. 40.)

Formæ glabræ et hirsutæ pro varietatibus distinctis haberi non possunt, am pro more in loco quoque promiscue occurrunt.

γ. f. LONGIBRACTEATA, *Domin*, f. n.

Bracteis longius acuminatis sæpe plus 18 mm. longis ; foliis hirsutis.

W. Australia : Swan River, legit Drummond.

2. Var. INTERCEDENS, *Domin*, var. n.

Dense fasciculato-cæspitosa, foliis rigidis glaberrimis scapis longioribus, scapis brevibus circiter 2–3½ cm. raro usque 5 cm. longis, bracteis brevibus margine purpureo-coloratis.

W. Australia : Yallingup et Cape Naturaliste, coll. A. A. Dorrien-Smith, 1909.

Quodam modo inter varietatem *typicam* et *acaulem* intermedia, sed certe varietas sui juris in statione nominata jam a cl. Oldfield in forma identica reperta.

3. Var. ACAULIS, *Domin*, comb. n. (=*J. acaulis*, Endl. in Pl. Preiss. vol. ii. p. 41 (Bentham, vii. 69 ; Baker, Journ. Linn. Soc., Bot. xv. (1877) p. 419 ; Diels, Fragm. 101). *J. hirta*, Lindl., var. *acaulis*, F. Mueller, Fragm. vii. p. 87.)

Scapo subnullo usque 1½ cm. vel paulo plus longo ; glabra.

W. Australia : Stirling Range (Mueller et alii) ; distr. Eyre (Diels), etc.

4. Var. DRUMMONDII, *Domin*, comb. n. (=*J. acaulis*, Endl., var. *Drummondii*, Baker, *l. c.* p. 419.)

Præcedenti affinis, sed robustior, foliis latis ubique pubescentibus, capitulis majoribus, bracteis dorso pubescentibus.

Australia occidentalis : rara.

BORYA, *Labill.*

B. NITIDA, *Labill.* (Bentham, vii. 71 ; Diels, Fragm. 102).

W. Australia : Bridgetown usque Kojonup et Slab Hut Gully ; Mallet, loco utroque coll. A. A. Dorrien-Smith, 1909.

Species quam maxime variabilis formis et varietatibus admodum divergentibus ludit sed specimina numerosa distinctionem exactam in species diversas non permittunt.

XEROTES, *Banks.*

X. ENDLICHERI, *F. Muell.* (Bentham, vii. 101).

W. Australia : Bridgetown usque Kojonup et Slab Hut Gully, coll. A. A. Dorrien-Smith, 1909.

X. PURPUREA, *Endl.* (Bentham, vii. 101).

W. Australia : Yallingup et Cape Naturaliste et cum præcedente, loco utroque legit A. A. Dorrien-Smith, 1909.

X. PAUCIFLORA, *R. Br.* (Bentham, vii. 104).

W. Australia : Mt. Toolbrunup, collegit idem, 1909.

ACANTHOCARPUS, *Lehm.*

A. PREISSII, *Lehm.* (Bentham, vii. 111 ; Diels, Fragm. 102).

W. Australia : Yallingup et Cape Naturaliste, coll. A. A. Dorrien-Smith, 1909.

DASYPOGON, *R. Br.*

D. BROMELIIFOLIUS, *R. Br.* (Bentham, vii. 118).

W. Australia : Yallingup et Cape Naturaliste, coll. A. A. Dorrien-Smith, 1909.

Forma a typo aliquantum aberrans, sed ob setas longas facile deciduas ad speciem hanc referenda. Scapi quoque indumentum haud est typicum. Forsan forma juvenilis (capitulum haud florens).

PHILYDRACEÆ.

PRITZELIA, *F. Muell.*

P. PYGMÆA. *F. Muell.* (Bentham, vii. 74).

W. Australia : Yallingup et Cape Naturaliste, coll. A. A. Dorrien-Smith, 1909.

SCHEUCHZERIACEÆ.

TRIGLOCHIN, *L.*

T. PROCERA, *R. Br.* (Bentham, vii. 168).

W. Australia : Cranbrook usque Warrungup, in arenosis, coll. A. A. Dorrien-Smith, 1909.

Species habitu et præcipue foliorum latitudine valde variabilis sed formæ intermediæ numerosæ tantum varietates minoris pretii indicare videntur. Forma nostra inter varietates *typicam* et *eleutherocarpam* Benth. medium tenet et habet folia pro specie sublatiora, 5 mm. vel paulo plus lata.

Cl. Buchenau (Engler's Pflanzenreich, iv. 14. (1903) p. 14) bene dicit formas numerosas primo aspectu valde divergentes separari non posse.

RESTIONACEÆ.

ANARTHRIA, *R. Br.*

A. SCABRA, *R. Br.* (Bentham, vii. 212).

W. Australia : Albany, collegit B. J. Goadby m. Octobre 1896 (♂ et ♀).

A. GRACILIS, *R. Br.*, var. COMPLANATA, *Domin*, var. n.

Tantum planta mascula mihi obiacet ; excellit culmis compressis planis circiter 1¾ mm. latis 16–30 cm. altis foliis brevioribus, foliis vaginis compressis carinatis laminis planis ensiformibus usque 2½ mm. latis instructis, bractea paniculam fulcrante mature decidua, paniculis pyramidalibus laxioribus brunneo-stramineis nitentibus circa 4–4½ cm. longis, bracteolis totis scariosis, perianthii segmentis ca. 7 mm. longis, antheris circiter 3½ mm. longis.

W. Australia : in arenosis prope Warrungup, coll. A. A. Dorrien-Smith, 1909.

Forsan species propria, sed varietas *ischæmoides* (Nees in Pl. Preiss. vol. ii. p. 62 pro sp.) varietatem nostram cum typo conjungere videtur.

A. PROLIFERA, *R. Br.* (Bentham, vii. 213).

W. Australia : in arenosis prope Warrungup cum præcedente, legit idem.

HYPOLÆNA, *R. Br.*

H. EXSULCA, *R. Br.* (Bentham, vii. 240 ; Gilg in Fragm. 89).

W. Australia : prope Mallet, collegit A. A. Dorrien-Smith, 1900 (♂).

LOXOCARYA, *R. Br.*

L. FASCICULATA, *Benth.* (Bentham, vii. 242 ; Gilg in Fragm. 90).

W. Australia : Bridgetown usque Kojonup et Slab Hut Gully, coll. A. A. Dorrien-Smith, 1900 (♂).

CYPERACEÆ.

CYPERUS, *Linn.*

C. BULBOSUS, *Vahl* *.

N.W. Australia : inter fl. Ashburton et Yule, coll. Dr. E. Clement.

Indigenis "*Nalgoo*" dicitur et tubera ejus comeduntur. Tubera sicca sunt ovata acuta usque 1½ cm. longa et 8 mm. lata, sed sæpe minora.

Eadem species in Australia orientali reperitur ; vidi specimina a cl. Ferd. Mueller ad fl. Brisbane River (Queensland) collecta.

C. VAGINATUS, *R. Br.* (Bentham, vii. 272), var. TYPICUS.

N.W. Australia : inter fl. Ashburton et De Gray, leg. Dr. E. Clement.

C. VAGINATUS, *R. Br.*, var. CONTRACTUS, *Domin*, var. n.

Inflorescentia contracta brevi (sed haud compacta) sæpius depauperata 1–2 cm. longa, bracteis numerosis (pro more 5–6) planis inflorescentia multo longioribus (usque 9 cm. longis) suffulta.

In Australia boreali-occidentali cum præcedente coll. Dr. E. Clement.

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* Cl. C. B. Clarke in schedis determinavit.

FIMBRISTYLIS, *Vahl.*

F. CARDIOCARPA, *F. Muell.* (Bentham, vii. 303). (Plate **12**. fig. 21.)

N.W. Australia: inter fl. Ashburton et De Gray, coll. Dr. E. Clement (specimina numerosa!).

Species inter congeneras distincta, adhuc tantum ex Australia boreali (Upper Victoria River, coll. F. Mueller) nota. Styli rami adsunt semper 3.

Eodem loco collegit cl. Clement formam verosimiliter ad speciem hanc referendam, sed gracilitate, spiculis bractea basi glumiformi sed apice filiformi-elongato et spiculam juvenilem superante fulcratis notabilem, sed ob fructus deficientes ulterius observandam.

BULBOSTYLIS, *Nees.*

B. BARBATA, *C. B. Clarke.* (=*Fimbristylis barbata*, Bentham, vii. 321. *Isolepis barbata*, R. Br. Prodr. 222.)

N.W. Australia: inter fl. Ashburton et De Gray, coll. Dr. E. Clement.

Species per Australiam valde divulgata.

CAUSTIS, *R. Br.*

C. DIOICA, *R. Br.* (Bentham, vii. 422).

W. Australia: Cranbrook usque Warrungup, in arenosis; Slab Hut Gully usque Cranbrook, loco utroque collegit A. A. Dorrien-Smith, 1909.

Forma prior est pro specie nimis robusta.

GRAMINEÆ.

PANICUM, *Linn.*

P. DECOMPOSITUM, *R. Br.* (Bentham, vii. 489), var TYPICUM, *Domin.*

N.W. Australia: inter fl. Ashburton et Yule, coll. Dr. E. Clement; inter fl. Ashburton et De Gray, collegit idem.

Forma typica habet pro more glumam primam perbrevem latissimam truncatam obtussimam, sed occurrunt interdum formæ a varietate *typica* haud separandæ gluma prima truncata uninervi in acumen parvum subito protracta excellentes. Plantæ nostræ foliis exacte lævibus gaudent.

P. DECOMPOSITUM, *R. Br.*, var. ACUMINATISSIMUM, *Domin*, var. n.

Excellit foliis elongatis angustis acuminatissimis perfecte lævibus vel rarius scabris, vaginis glabris lævibusque, ligulis elongatis parte inferiore integris parte superiore lacerato-ciliatis vel in cilias dissolutis, panicula minore, rhachi scabra, ramis ramulisque patentibus strictioribus scabris, spiculis sæpe singulis, gluma prima scariosa latissima truncata sed subacuta.

Varietas hæc characteribus datis conspicua et a typo valde divergens in duabus reperitur formis, i. e. f. *lævifolia* (foliis una cum vaginis perfecte glabris lævibusque) et f. *scaberula* (foliis præsertim in pagina superiore scabris), quæ rarius occurrit.

(*a*) N.W. Australia: inter fl. Ashburton et De Gray, coll. Dr. E. Clement.

(*b*) Elder Exploring Expedition, Camp 15, collegit R. Helms, 6 Augusto, 1891.

(*c*) Mt. Lyndhurst, collegit Max Koch, m. Martio 1899 (M. Koch, South Austral. Plants, No. 448, *Panicum decompositum*, "Umbrella-grass"). Cl. Koch in schedis annotat: "Good fodder, growing in moist situations.—Aboriginal names: Talghee, Allee, Koothoo, Caltharathie; seed=powa rhandra, which the Blacks eat."

(*d*) Macquaries and Castlereags Rivers, coll. Wools.

Panicum lævinode, Lindl. in Mitchell, Three Exped. into the Interior of Eastern Australia, vol. i. (1839) p. 238 (adnot.), quod cl. Bentham pro synonymo *P. decompositi* declarat, est verosimiliter cum varietate nostra identicum, sed, cum descriptio Lindleyana authentica valde manca sit ("panicula composita contracta capillari, ramis pedicellisque flexuosis, spiculis acutis glabris, gluma exteriore rotundata laxa, interiore 5-nervi, *foliis vaginis geniculisque glabris lævibus*"), speciem hanc varietati nostræ omnino adæquare pro certo affirmare non audeo.

PANICUM DECOMPOSITUM, *R. Br.*, var. SCABERRIMUM, *Domin*, var. n.

Varietati præcedenti affine, foliis elongatis acuminatissimis sed ad laminæ basin latioribus (usque 1 cm. vel paulo plus latis) in pagina superiore et marginibus scaberrimis subtus perfecte lævibus, vaginis setis brevibus suberectis valde hispidis, ligulis parte basali integris, paniculæ rhachi valde scabra, spiculis majusculis, gluma prima obtusa vel sæpius subacuta.

N.W. Australia: inter fl. Ashburton et De Gray, collegit Dr. E. Clement; promiscue cum varietate præcedente, sed rarissime.

Varietas indumento et asperitate memorabilis!

P. DECOMPOSITUM, *R. Br.*, var. UTILE, *Domin*, var. n. (an species propria ?).

Differt a typo præcipue gluma quarta intense nitente luride olivaceo-viridi nervis 5 usque 7 manifeste striata; cæterum habet folia fere lævia, rhachin scabram, paniculam valde decompositam demum divaricatam, glumam primam truncatam obtusam vel obscure dentatam brevem, glumam secundam et tertiam 7-nervem.

N.W. Australia: inter fl. Ashburton et Yule, collegit Dr. E. Clement.

Specimina numerosa sed parte inferiore destituta, quam ob causam diiudicare nequeo, utrum planta perennis an annua sit. Forsan species a *P. decomposito* diversa sed specimina fragmentosa æstimationem certam haud permittunt.

P. psilopodium a varietate nostra gluma prima acuta, gluma secunda 11-nervi facile dignoscitur.

PANICUM AUSTRALIENSE, *Domin*, sp. n. (Plate **10.** fig. 10; Plate **11.** figg. 8–12.)

Annuum; *culmi* e radice fibrosa numerosissimi fasciculato-cæspitosi, medii suberecti, cæteri e basi plus minusve decumbente geniculatim ascendentes valde ramosi parte superiore fastigiati toti foliati glabri læves vel parte superiore interdum scaberuli humiles usque 1 dm. alti sed sæpe humiliores. *Folia* laminis planis longe angustatis et acuminatis subpatentibus circiter 4–6 cm. longis et 2–2½ mm. latis scaberulis pro more glabris rarius præsertim ad basin uti vaginis infimis mediisque sat dense setis albidis patentibus e tuberculis enatis inspersis instructa; *ligulæ* in cilias mediocriter longas dissolutæ; folia culmea suprema approximata paniculam manifeste superantia. *Paniculæ* numerosæ sed breves circa 2¼–3 cm. longæ ramos paucos (2–3) breves paucispiculatos simplices erectos vel demum subpatentes gerentes parte superiore simplices vel subsimplices; rhachis ramique glabri scaberuli. *Spiculæ* pro specie sat magnæ longiuscule pedicellatæ circa 4 mm. longæ late ovato-oblongæ pallidæ glabræ; *gluma prima* e basi amplectente late ovata acuta 5-nervis, nervo medio acute prominulo, tertia parte usque duplo gluma tertia brevior; *gluma secunda* et *tertia* consimiles æquilongæ 3½–3¾ mm. longæ ovatæ concavæ tenues uti gluma prima glaberrimæ læves pallidæ 5-nerves (nervis viridibus), *gluma quarta* (*glumella*) multo (circa duplo) brevior circiter 1¾ mm. longa valde concava nitens enervosa, palea paulo brevior. *Caryopsis* ovato-oblonga lævis obtusiuscula glumella et palea subbrevior.

N.W. Australia: inter fl. Ashburton et Yule, collegit Dr. E. Clement.

P. australiense est species inter congeneras distinctissima, nulli arcte affinis; verosimiliter seriei VI. *Paniculatæ* (Bentham, vii. 466) inserenda et prope *P. adspersum*, Trin. collocanda erit. Habitu singulari primo aspectu facile distinguitur, præterea spicularum structura peculiaris est.

PANICUM INTERCEDENS, *Domin*, sp. n. (Series III. *Paspaloideæ*, Bentham, vii. 464.)

Habitu *P. distachyo*, L. simillimum eique affine. *Culmi* graciles fere a basi ramosi glaberrimi lævesque cum panicula circa 3 dm. et ultra alti sæpe usque ad apicem foliati paucinodi. *Folia* distantia: *laminæ* suberectæ planæ lanceolatæ acutæ basi subcordatæ margine tenuiter cartilagineo albido undulatæ breviores, *i. e.* 4½–6 cm. longæ et basi, qua latissime patent, 5–6½ mm. latæ glabræ vel pilis e tuberculis enatis inspersæ; *vaginæ* læves glabræ margine longiuscule ciliatæ; *ligulæ* in cilias dissolutæ. *Paniculæ* e ramis paucis (ramo terminali annumerato pro more tribus) simplicibus valde distantibus (spatio inter ramum infimum et superpositum ca. 4 cm.) primo erectis postea patentibus demum reflexis compositæ ; paniculæ rhachis excavata glabra, ramuli complanati glabri pro more spiculam terminalem gerentes. *Spiculæ* subdistantes biseriatæ sed unilaterales fere sessiles majusculæ circa 4½ mm. longæ pallidæ vel interdum parce coloratæ ; *gluma prima* glabra spicula duplo brevior amplectens acuta vel subacuta pro more 7-nervis tenuis ; *gluma secunda* et *tertia* ovato-oblonga acuta 3-nervis (nervis acute prominentibus) dorso breviter apice ad margines longius pilosa ; *gluma quarta* (*glumella*) paulo brevior 3¼ mm. longa subacuta elliptico-oblonga lævis sed haud nitens obscure 3-nervis minutissime rugulosa glabra.

N.W. Australia : inter fl. Ashburton et De Gray, collegit Dr. E. Clement.

Species distincta prope *P. distachyum*, L., cui est similis, inserenda, sed differt præter alia spiculis majoribus hirsutis. A *P. piligero*, F. Muell., Australiæ borealis incola, facile dignoscitur glabritie et foliis brevibus lanceolatis.

Panicum Clementii, *Domin*, sp. n. (Series III. *Paspaloideæ*, Bentham, vii. 464.)

Verosimiliter annuum ; *culmi* basi valde ramosi et decumbentes geniculatim ascendentes et deinde erecti cum paniculis circa 30 usque 35 cm. alti glabri sæpius usque ad paniculam foliati plurinodi. *Folia* laminis planis mollibus linearibus longe acuminatis glabris vix scaberulis circa 9–12 cm. longis et 3–4½ mm. latis nervo medio albido percursis et vaginis tenuibus glabris sæpe subpatentibus instructa ; *ligulæ* in cilias dissolutæ ; lamina folii culmei supremi paniculæ apicem haud raro attingens. *Panicula* elongata plus 10 cm. (et interdum usque 15 cm.) longa, paniculæ rami alterni distantes suberecti (nec patentes), infimi sat longi (usque 4 cm.) a basi spiculigeri parum ramulosi ramulis perbrevibus adpressis instructi, superiores subsimplices vel vix ramulosi breviores spiculas haud numerosas irregulariter dispositas (*i. e.* series conspicuas haud efformantes) gerentes ; paniculæ rhachis glabra lævisque, rami vix applanati tenues ad angulos scabri, ramorum rhachis aristiformis spiculam supremam fulcrans interdum superans. *Spiculæ* pallidæ subsessiles parvæ tantum 2 mm. vel paulo plus longæ oblonge ellipticæ obtusæ ; *gluma prima* membranacea 3-nervis subobtusa glabra 1–1·2 mm. longa ; *gluma secunda* et *tertia* subæquales ovatæ obtusiusculæ obtusæve glabræ membranaceæ, secunda nervis 5 viridibus perfectis et 2 imperfectis, tertia nervis 3 viridibus perfectis et 2 parte superiore evanescentibus striata ; *gluma quarta* (*glumella*) obtusiuscula vel subacuta elliptica fere 2 mm. longa minute rugulosa (fere lævi) haud manifeste nervosa amplectens ; palea subbrevior arcte adpressa lævis.

N.W. Australia : inter fl. Ashburton et Yule, collegit Dr. E. Clement, cui speciem hanc dedico.

P. Clementii prope *P. prostratum*, Lam. inserendum erit, sed haud est huic arcte affine.

SETARIA, *Beauv.*

S. VERTICILLATA, *Beauv.* (Bentham, vii. 494).

N.W. Australia : inter fl. Ashburton et Yule, coll. Dr. E. Clement ; inter fl. Ashburton et De Gray, collegit idem.

XEROCHLOA, *R. Br.*

X. LANIFLORA, *Benth.* (Bentham, vii. 502 ; O. Stapf in Fragm. 65).

N.W. Australia : inter fl. Ashburton et Yule, collegit Dr. E. Clement (specimina numerosa, optime conservata).

Species me judice annua habitu a congeneris (*X. imberbis*, R. Br. et *barbata*, R. Br.) primo aspectu facile dignoscenda.

SPINIFEX, *L.*

S. LONGIFOLIUS, *R. Br.* (Bentham, vii. 504).

N.W. Australia : inter fl. Ashburton et De Gray, collegit Dr. E. Clement.

W. Australia : Yallingup et Cape Naturaliste, collegit A. A. Dorrien-Smith, 1909.

NEURACHNE, *R. Br.*

N. ALOPECUROIDES, *R. Br.* (Bentham, vii. 507 ; Pilger in Fragm. 69).

W. Australia : Warrungup Hill, Stirling Range, collegit A. A. Dorrien-Smith ; Bridgetown usque Kojonup et Slab Hut Gully, collegit idem.

NEURACHNE CLEMENTII, *Domin*, sp. n. (Plate **10**. figg. 1–6.)

Perennis ; *culmi* basi duri dense villosi plurinodi circa 3 dm. vel ultra alti graciles glaberrimi sed nodis barbati. *Folia* haud numerosa distantia laminis planis mollibus subpatentibus acuminatis usque 4 mm. latis subglaucis glabris vel iis foliorum infimorum pilis perpaucis e tuberculis enatis inspersis usque plus 10 cm. longis sed iis foliorum supremorum multo brevioribus instructa ; *vaginæ* glabræ vel raro pilis perpaucis tuberculis insidentibus munitæ ad oram ciliatæ nunc culmum arcte amplectentes nunc subpatentes ; *ligulæ* breves in cilias dissolutæ. *Paniculæ* oblongo-cylindricæ haud interruptæ subdensæ erectæ vel paulo subnutantes argenteo-nitidulæ circa $3\frac{1}{2}$–$3\frac{3}{4}$ cm. longæ ; paniculæ rhachis glabra. *Spiculæ* brevissime-pedicellatæ, basi longiuscule patentim barbatæ, pilis usque $2\frac{1}{2}$ mm. longis ; pedicelli apex parum excavatus articulatus ; *gluma prima* e basi dilatata amplectens anguste lanceolata longe tenuiter acuminata (fere aristulata) 11–12 mm. longa plerumque nervis 7 prominentibus striata extus et intus glaberrima sed margine setis longis sparsis e tuberculis enatis munita viridis sed parte basali amplectente in utroque latere scariosa et demum a parte media viridi rumpens ; *gluma secunda* fere æquilonga vel parum longior sed altius amplectens utroque latere pilis longissimis densis patentibus ciliata; *gluma tertia* 5-nervis lanceolata subacuta glabra circa 7 mm. longa; *gluma quarta* (*glumella*) æquilonga scariosa bicarinata; palea subbrevior lævis, stigmata elongata plumosa. *Caryopsis* subcompresse orbiculato-obovata lævis circa 1¾ mm. longa.

N.W. Australia: inter fl. Ashburton et Yule, collegit Dr. E. Clement.

Species inter congeneras distinctissima, generis *Neurachnæ* in Australia endemici quinta, cum nulla alia arcte affinis, iam habitu et paniculæ forma insignis.

PEROTIS, *Ait.*

P. RARA, *R. Br.*, var. EURYPHYLLA, *Domin*, var. n.

Excellit foliis glaucis brevibus planis latioribus folio culmeo supremo usque 4 mm. lato, racemo (spica) graciliore densiore, spiculis subsessilibus reflexis cum aristis tantum circa 2 cm. longis.

N.W. Australia: inter fl. Ashburton et Yule, collegit Dr. E. Clement.

Varietas notabilis aliquid ad *P. latifoliam*, Ait. spectans, sed speciem hanc nimis diversam et præcipue spiculis sub fructu quoque erectis facile dignoscendam cum *P. rara* conjungere vix naturale videtur.

HETEROPOGON, *Pers.*

H. CONTORTUS, *Roem. et Schult.* (Bentham, vii. 517). (=*Andropogon contortus*, Linn.)

N.W. Australia: inter fl. Ashburton et Yule, collegit Dr. E. Clement.

POLLINIA, *Trin.*

P. FULVA, *Benth.* (Bentham, vii. 526; Pilger in Fragm. 69). (=*Saccharum fulvum*. R. Br. Prodr. 203.)

N.W. Australia: inter fl. Ashburton et Yule, collegit Dr. E. Clement.

ANDROPOGON, *L.*

A. BOMBYCINUS, *R. Br.* (Bentham, vii. 533).

N.W. Australia: inter fl. Ashburton et De Gray, collegit Dr. E. Clement.

A. PROCERUS, *R. Br.* (Bentham, vii. 532).

N.W. Australia: inter fl. Ashburton et De Gray, coll. Dr. E. Clement.

Varietas a typo spiculis ☿ usque 6 mm. vel paulo plus longis divergens.

CHRYSOPOGON, *Trin.*

C. GRYLLUS, *Trin.*, var. PALLIDUS, *Benth.* (Bentham, vii. 537). (=*Holcus pallidus*, R. Br. Prodr. 199. *Pollinia pallida*, Roem. et Schult. Syst. ii. 829.

Andropogon pallidus, Kunth, Enum. i. 505. *Andropogon Gryllus*, L., subsp. *genuinus* c. *pallidus*, Hackel in Mon. Phaner. vol. vi. 552.)

N.W. Australia ; inter fl. Ashburton et Yule, collegit Dr. E. Clement.

Varietas hæc præcipue in Australia tropica reperitur.

SORGHUM, *Pers.*

S. PLUMOSUM, *Beauv.* (Bentham. vii. 540).

N.W. Australia : inter fl. Ashburton et De Gray, collegit Dr. E. Clement.

Forma rhachi perfecte lævi, ramulis scabris, columna secus spiras breviter ciliata insignis.

Var. *typicum*, Domin (= *Andropogon australis*, Spreng., subsp. a. *plumosum* var. *α. genuinus*, Hack. *l. c.* 523), prope Ashburton River a cl. Stuart-Carey, collecta fuit (Hackel, *l. c.*).

Ex cl. E. Hackel *Sorghum plumosum* paniculæ ramis rhachique scabris insignis est, sed vidi specimina authentica Roberti Brownii (sub *Holco plumoso*) (Herb. R. Brown, No. 6192, North Coast), quæ rhachi et ramulis glabris ævibusque conspicua sunt.

S. INTRANS, *F. Muell.* (Bentham, vii. 541). (= *Andropogon intrans*, F. Muell.)

N.W. Australia : inter fl. Ashburton et Yule, collegit Dr. E. Clement.

Tantum Australiæ tropicæ præcipue borealis indigena videtur.

AMPHIPOGON, *R. Br.*

A. DEBILIS, *R. Br.*, var. FALLAX, *Domin*, var. n.

Dense cæspitosus rigidus, culmis erectis gracilibus sed rigidiusculis strictisque elatioribus circa 25–30 cm. altis, foliis rigidis erectis glaucis, panicula sæpe 2 cm. longa erecta densa, spiculis majoribus usque 1 cm. longis.

Habitat in Australia occidentali ad Oulina, ubi eam legit m. Novembre 1907, Max Koch (Exsicc. Fl. of W. Austr. No. 1828).

Varietas egregia habitu a forma typica, quæ culmis humilioribus plus minusve decumbentibus, spiculis parvis paniculisque laxis excellit, primo aspectu valde abhorrens sed etsi habitu *A. stricto*, R. Br. similis appareat, sine dubio ad *A. debilem* inserenda est. Cl. F. Mueller (Fragm. viii. 201) speciem utramque sub *A. Brownii* junxit, sed cl. Bentham bene commemorat *A. debilem* et *strictum* sat differre et species bene distinctas sistere.

A. debilis varietas *typica* est latius per Australiam occidentalem diffusa; vidi specimina authentica a cl. R. Brown (sub no. 6228) necnon a cl. Baxter, Drummond (no. 117) et aliis collecta.

Forma a cl. Cecil Andrews collecta (in arenosis, Mt. Clarence prope Albany, Exsicc.: C. Andrews 1st coll. No. 1213, ineunte m. Jan. 1903) inter varietatem nostram et typicam medium tenet vel potius v. *fallaci* propius accedit. Habet enim habitum rigidiorem var. *fallacem* revocantem, sed culmos graciliores humiliores et geniculatim ascendentes, paniculas densas sed minus densas quam in varietate *fallaci* e spiculis haud numerosis compositas, spiculas sat magnas.

AMPHIPOGON STRICTUS, *R. Br.*, var. SETIFER, *Benth.* (Bentham, vii. 598).

W. Australia : Oulina, collegit Max Koch m. Novembre 1907 (Exsicc. Fl. of W. Austr. No. 1827).

A. STRICTUS, *R. Br.*, var. OCCIDENTALIS, *Pilger* in Fragm. 71 (vel ei proximus).

W. Australia : Cowcowing, coll. Max Koch m. Octobre 1904 (Exsicc. No. 1214).

Plantæ a cl. Koch collectæ descriptionem varietatis *occidentalis* apud Pilger, *l. c.* bene quadrant ; excellunt culmis valde elatis, paniculis pauci-spiculatis et perangustis, glumis glabris, aristis ciliatis.

A. STRICTUS *R. Br.*, var. DESERTORUM, *Domin*, var. n.

Excellit culmis elatis foliatis, foliis pallidis culmeis erectis elongatis, lamina folii culmei supremi paniculam attingente vel superante, paniculis spiciformibus cylindricis subdensis pallidis, spiculis longius pedicellatis minoribus, glumis cum aristis tantum circa 5 mm. vel paulo plus longis, aristis glumis vix tertia parte longioribus.

"Mr. Gosse's Expedition, Centre of South Australia, No. 156 (comm. R. Schomburgk, 1874)."

Species propria esse videtur, sed *A. strictus* exhibet typum admodum variabilem, cujus varietates primo constantes et magni valoris apparent sed si formas omnes respicis, limites certi trahi non possunt.

A. caricinus, F. Muell. (Linnæa, xxv. 445) postea ab ipso auctore pro synonymo *A. Brownii* declaratus, cum varietate nostra identicus esse videtur, sed specimen Muellerianum authenticum in herbario Kewensi conservatum et prope fl. Murray lectum incompletum est et descriptio authentica manca diiudicare haud permittit, quod cl. Mueller sub specie sua comprehendit. Specimen hoc formam varietatis nostræ sistere videtur accurate haud determinandam.

A. CONFUSUS, *Domin*, n. sp.

A. laguroides, Bentham, vii. 598, quoad descriptionem et stationes pro parte, *non* R. Brown, Prodr. 175.

Cl. Bentham sub *A. laguroide* et *A. cygnorum* species tres bene distinctas comprehendit. *A. confusus* ab *A. laguroide* vero culmo pubescente, foliis pro more hirsutis, glumellis trilobis nec aristatis facile dignoscitur. Descriptio Benthamiana speciem nostram bene quadrat.

Vidi specimina numerosa a cl. Drummond in distr. Swan River (1839) collecta.

A. LAGUROIDES, *R. Br.* Prodr. 175, nec *Bentham*!

A præcedente præcipue glabritie perfecta, aristis brevibus dignoscendus!

Vidi specimen authenticum cl. R. Brownii (sub no. 6225), præterea plantas a cl. Oldfield (King George's Sound, no. 663; Bunbury no. 1002 in planitie ericetosa, Bentham pro *A. cygnorum*) et Cecil Andrews (1st coll. No. 1214, *A cygnorum*, prope Albany, "open heathy ground") collectas.

A. CYGNORUM, *Nees* in Pl. Preiss. vol. ii. 100 (Bentham, vii. 599, pro parte).

Aristis longissimis capillaribus ab utraque specie præcedente facillime distinguitur.

In Australia occidentali stationibus numerosis reperitur; vidi specimina a cl. Drummond, Oldfield et Pritzel (in districtu Murray: in silvis apertis arenosis *Eucalypti marginatæ*, m. Decembre 1900, Exsicc. No. 122) collecta.

Variat aristis violaceo-coloratis (*e. g.* planta Pritzeliana) et pallidis (Drummond, no. 398).

Jam apud cl. Nees (*l. c.* p. 101) scriptum legimus: *A. cygnorum* differt ab *A. laguroide* statura altiore et setis (violaceis) flosculi multo longioribus.

PAPPOPHORUM, *Schreb.*

P. NIGRICANS, *R. Br.*, var. BARBINODE, *Domin*, var. n.

Fasciculato-cæspitosum multiculme, culmis gracillimis humilioribus parte superiore nudis geniculatim ascendentibus vel e basi decumbente erectis minus ac 2 dm. altis sub panicula tractu breviore subpubescentibus, foliis brevibus, laminis in pagina superiore plus minusve pubescentibus vel glabrescentibus, vaginis glabris et ea folii culmei supremi excepta mox subpatentibus itaque nodis conspicuis, nodis patentim barbato-villosis, paniculis brevibus oblongis vel ovato-oblongis 1–2 cm. longis et 6–9 mm. latis, spiculis parvis cum aristis $4\frac{1}{4}$–$4\frac{1}{2}$ mm. longis, glumis inæqualibus pallidis subhirsutis, glumellis parvis glumis tantum circa tertia parte longioribus, aristarum pilis sæpius subcoloratis.

N.W. Australia: inter fl. Ashburton et De Gray, coll. Dr. E. Clement.

Varietas notabilis arenosorum incola a typo sat diversa sed *P. nigricanti* per Australiæ regiones multas pervulgato et valde variabili associanda.

TRIRAPHIS, *R. Br.*

T. MOLLIS, *R. Br.*, f. CÆSPITITIA, *Domin*, f. n.

Dense fasciculato-cæspitosa multiculmis, foliis brevioribus, culmis humilioribus vix 25 cm. altis (sæpe humilioribus) plus minusve geniculatim ascendentibus, paniculis densis nitentibus pallidis vel coloratis.

N.W. Australia : inter fl. Ashburton et De Gray, collegit Dr. E. Clement.

Forma insignis habitu a typo valde abhorrens. Varietas *typica* (vidi specimina authentica R. Brownii sub no. 6248) excellit culmis erectis elatis plus 6 dm. altis, foliis valde elongatis, paniculis magnis usque plus 6 dm. longis valde lobatis sed minus densis et crescit in cæspitibus minoribus pauciculmibus. Forma *cæspititia* mihi in speciminibus numerosis obiacens constans esse videtur, sed nihilo minus me judice tantum formam xerophilam arenosis accomodatam exhibet et characteres apud arenosorum incolas obvios ostendit.

T. mollis gignit in solo fertili humidiore formas robustas usque 10 dm. altas, ut ipse prope fl. Flinders in Queensland observavi.

Forma *cæspititia* reperitur etiam in Australia meridionali (Max Koch, South Australian Plants, No. 92, Mt. Lyndhurst, m. Septembre 1899, "on sandy flats").

TRIODIA, *R. Br.*

TRIODIA LANIGERA, *Domin*, sp. n.

More *T. pungentis* cæspitosa sed minus rigida ; *folia* arcuato-patentia usque divaricata eximie glauca lævia glabraque (sed statu juvenili parte inferiore lanata) rigidiuscula sed haud rigidissima plana sed angusta circa 1 mm. vel usque $1\frac{1}{2}$ mm. lata sed haud raro partim vel fere tota convoluta apice cartilagineo valde pungentia longissima sæpe longitudinem 2 dm. superantia haud conspicue viscosa ; *vaginæ* dense albo-lanatæ sed lanugine detersili instructæ vaginæque vetustiores sæpe partim vel totæ glabratæ. *Culmi* elati exserti glabri. *Paniculæ* angustæ circiter 12–14 cm. longæ subdensæ pallidæ, paniculæ rami breves erecti vel suberecti. *Spiculæ* permagnæ 15–18 mm. longæ pro more 6–7 floræ ovato-oblongæ ; *glumæ* pallidæ ovato-lanceolatæ acutæ circa 10 mm. longæ margine plus minusve pilosæ cæterum glabræ flosculis circa tertia parte vel paulo ultra breviores multinerves, nervis circa 15–18 valde conspicuïs viridibus sed haud prominulis et 4 parte superiore evanescentibus percursæ ; *flores* conferti ; *glumella* infima usque fere 10 mm. longa dorso rotundato pilis brevibus appressis albidis dense pubescens ad $\frac{3}{5}$ triloba, lobo medio anguste lanceolato acuminato usque plus 6 mm. longo, lobi laterales tertia parte breviores circiter 4–$4\frac{1}{4}$ mm. longi latiores (diametro basali circa $1\frac{1}{4}$ mm.) lanceolati, omnes extus pilosi vel pubescentes intus glabri membranacei sed nervo viridi (in lobo medio apice indurato) usque ad apicem et nervis lateralibus pluribus mox evanescentibus percursi, glumellæ sequentes gradatim breviores, pars glumellarum integra sub fructu indurata et ob nervos obsoletos æqualiter lævis ; *palea* margine ciliata nervis 2 cartilagineis percursa glumellæ parti integræ æquilonga vel ea fere sublongior.

N.W. Australia : inter fl. Ashburton et Yule, collegit Dr. E. Clement.

Species inter congeneras notabilis cum nulla alia arcte affinis, præcipue lanugine detersili et imprimis spicularum structura facile dignoscenda.—Generis *Triodiæ* species australienses adhuc incomplete notæ et ob hanc causam amplius investigandæ mihi videntur.

CYNODON, *Pers.*

C. DACTYLON, *Pers.* (Bentham, vii. 609).

N.W. Australia : inter fl. Ashburton et De Gray, collegit Dr. E. Clement.

ELEUSINE, *Gaertn.*

E. RADULANS, *R. Br.* Prodr. 186.

N.W. Australia : inter fl. Ashburton et Yale, collegit Dr. E. Clement.

Forma foliis glaucis et pro specie latis excellens.

E. radulans, R. Br., a cl. Bentham (vii. 615) pro synonymo *E. ægyptiacæ* declarata est sed mihi vix naturale videtur hanc plantam sat diversam cum specie nominata conjungere. *E. radulans* sistit typum per Australiam valde distributum et formis diversis ludentem.

SPOROBOLUS, *R. Br.*

S. AUSTRALASICUS, *Domin* in Fedde Repert. ix. (1911) p. 553. (*S. pulchellus*, Bentham, vii. 623 p. p. ; *non* Robert Brown, Prodr. 170 !) (Plate **11.** fig. 13.)

N.W. Australia : inter fl. Ashburton et De Gray, collegit Dr. E. Clement.

Species præcipue in Australia tropica pervulgata esse apparet. Mihi adhuc e New South Wales, Queensland et North Australia innotuerat.

S. australasicus est *Sporobolo coromandeliano*, Indiæ orientalis incolæ, valde affinis, sed differt foliis longioribus, panicula multo majore et præcipue spiculis longe pedicellatis et gluma inferiore gluma secunda tantum duplo vel triplo breviore.

ERIACHNE, *R. Br.*

E. ARISTIDEA, *F. Muell.*, var. ELEGANS, *Domin*, var. n.

Excellit lamina folii culmei supremi erecto-patente circa 12 cm. longa apicem paniculæ attingente vel superante, panicula subdensiore sub flore ob glumellas pilis longis sericeo-albidis densissime hirsutas argentea, paniculæ ramis suberectis, spiculis conspicue majoribus, glumis pallidis submembranaceis acuminatis multinervibus, gluma longiore circa 10 mm. longa, glumellis cum aristis 13–15 mm. longis pilosissimis.

N.W. Australia : inter fl. Ashburton et Yule, collegit Dr. E. Clement.

Var. *typica* differt culmo longe exserto, paniculis laxioribus plus divaricatis, spiculis minoribus, glumis rigidioribus coloratis, glumellis minus hirsutis. Varietas nostra forsan speciem propriam sistit (*Er. elegans* Dom. in sched.), sed specimina a cl. Clement collecta tantum culmorum partes superiores et paniculas exhibent et æstimationem certam haud permittunt.

ERIACHNE TUBERCULATA, *Domin*, sp. n. (Plate **11.** figg. 14-17.)

Annua, fasciculato-cæspitosa; *culmi* gracillimi ramosi plurinodi præcipue nodis superioribus geniculatim ascendentes fere ad apicem foliati humiliores circa 2 dm. alti sub panicula scaberuli cæterum supra glabri parte inferiore pilis e tuberculis enatis inspersi. *Folia* culmea omnia consimilia distantia eximie glauca; *vaginæ* laxæ brevissimæ circa 6–8 mm. longæ setis singulis vel binis e tuberculis enatis sat crebre inspersæ; *laminæ* planæ lanceolatæ breves 12–20 mm. longæ et basi circa 3½ mm. latæ præcipue ad margines setis crebris patentibus tuberculis insidentibus armatæ. *Paniculæ* pallidæ gracillimæ tenues circa 3½–5 cm. longæ sed vix 4 mm. latæ laxæ; paniculæ rami capillares, infimi sat longi sed erecti. *Spiculæ* longepedicellatæ (pedicellis spiculis pro more conspicue longioribus) bifloræ minimæ circa 2¼ mm. longæ; *glumæ* latæ ovatæ acutæ submembranaceæ flosculis paulo breviores pallidæ vel vix coloratæ pro more 5-nerves; *glumellæ* membranaceæ breviter mucronatæ præcipue dorso patentim hirsutæ; *paleæ* glumellis vix breviores integræ, carinis et dorso parte inferiore pilosæ. *Caryopsis* anguste ovato-oblonga.

N.W. Australia: inter fl. Ashburton et Yule, collegit Dr. E. Clement.

Species distinctissima prope *E. pulchellam* inserenda, habitu primo aspectu facile cognoscenda.

E. PULCHELLA, *Domin* in Fedde Repert. ix. (1911) p. 552.

Annua, densiuscule fasciculato-cæspitosa; *culmi* numerosissimi geniculato-erecti peripherici plerumque e basi decumbente ascendentes omnes gracillimi glabri humiles cum paniculis circa 10–13 cm. raro usque 15 cm. alti tantum inferne foliati insuper tractu longiore nudi. *Folia* mollioria brevia pilis patulis e tuberculis enascentibus hispido-hirsuta; *laminæ* planæ circa 1½–1¾ mm. latæ et in foliis infimis vix 1½ cm. longæ; folia culmea suprema fere ad vaginam longam plus minusve hirsutam reducta. *Paniculæ* angustæ lineari-oblongæ 2–3¾ cm. longæ et tantum ½–¾ cm. latæ subdensiusculæ coloratæ; rami paniculæ infimi longiores (usque 1 cm.) sed erecti superiores ad spiculas solitarias pedicellatas reducti, rami pedicellique capillares. *Spiculæ* bifloræ parvæ vix 3 mm. longæ glabræ flosculis subæquilongæ; *glumellæ* circa 2½ mm. longæ acutæ muticæ longe piloso-hirsutæ; *palea* angusta linearis acuminata dorso ciliato-hirsuta glumellæ æquilonga.

W. Australia: Mons Cupri, Whim Creek, collegit W. A. Mitchell.

N.W. Australia: inter fl. Ashburton et De Gray, collegit Dr. E. Clement.

Præcedenti affinis sed indumento, foliis superioribus fere ad vaginas reductis, panicula colorata necnon spicularum structura sat diversa.

E. OBTUSA, *R. Br.* (Bentham, vii. 632).

N.W. Australia : inter fl. Ashburton et Yule, collegit Dr. E. Clement. Forma glumis multinervibus subglabris excellens.

ERAGROSTIS, *Beauv.*

ERAGROSTIS XEROPHILA, *Domin*, sp. n. (Plate **12.** figg. 18–20.)

Dense cæspitosa ; *culmi* e basi lignosa bulboso-incrassata numerosi graciles arcuato-ascendentes usque ad paniculam foliati glabri cum paniculis circa 15–20 cm. alti ; basi incrassata vaginis latissimis brevibus pallidis breviter villosulis obtecta ; innovationes numerosæ elongatæ sed vaginis arcte amplexæ. *Folia* innovationum subdisticha ; *laminæ* patentes vel divaricatæ rigidæ breves basi subauriculatæ latæ planæque apice convolutæ pungentes circa 2–3 cm. longæ et quo latissime patent 1–1½ mm. latæ glabræ basi cartilaginosæ et ibi a vaginis articulatim rumpentes ; *vaginæ* glabræ marginibus sese obtegentibus et persistentibus instructæ ; folia culmea similia. *Panicula* erecta 4–7 cm. longa anguste cylindrica fere ad racemum reducta vel e fasciculis paucispiculatis subdistantibus composita, pro more paniculæ rami infimi abbreviati erecti et fasciculos 3–2-spiculatos efformantes parte superiore spiculæ singulæ subsessiles vel breviter pedicellatæ. *Spiculæ* rigidæ anguste cylindricæ apice parum angustatæ 11 usque 23-floræ plus minusve falcatæ circa 7–10 mm. longæ et 1¼–1½ mm. latæ medio sulcatæ (nec teretes) ; *glumæ* ovatæ subæquales fere totæ scariosæ circa 1¾ mm. longæ ; *glumellæ* densiusculæ imbricatæ sub fructu magis patentes et interdum subremotiusculæ circa 2–2¼ mm. longæ acute carinatæ et nervo laterali medio acuto percursæ subacutæ glabræ interdum minus intense violaceo-coloratæ et apice demum haud raro in lobos 2 breves laceratæ ; *paleæ* glumellis paulo breviores angustæ margine minutissime ciliatæ ; stamina 3.

N.W. Australia : inter fl. Ashburton et De Gray, collegit Dr. E. Clement.

Species culmis basi valde incrassatis, foliis subdistichis rigidis pungentibus, paniculis fere ad racemos reductis, spiculis multifloris etc. insignis et in affinitatem *E. eriopodæ*, Benth. et *E. chætophyllæ*, Steud. spectans. Vidi specimina probabiliter ad speciem hanc referenda (Fraser Range, Elder Exploring Expedition), quæ *E. xerophilam* propius accedere videntur.

III. PTERIDOPHYTA.

LINDSÆA, *Dryand.*

L. LINEARIS, *Swartz*, var. TYPICA ; pinnis flabellatis æquilateralibus duplo latioribus ac longis.

W. Australia : Yallingup and Cape Naturaliste, coll. A. A. Dorien-Smith, 1909.

LINDSÆA LINEARIS, *Swartz*, var. CUNEATA, *Domin*, var. n.; pinnis oblique cuneatis paulo vel vix latioribus ac longis.

Per Australiæ partem maximam pervulgata esse apparet et sæpe pro typo speciei habetur.

L. linearis ex cl. Swartz (Syn. Filic. p. 118 et 318, tab. 3. fig. 3, 1806) excellit "fronde pinnata lineari, pinnis brevissimis subflabelliformibus antice crenulatis"; "pinnæ suboppositæ minutæ subsessiles flabelliformes s. basi cuneatæ sursum deorsumque planæ antice rotundatæ crenulatæ segmento quartæ partis circuli similes."

Forma a cl. Swartz descripta et delineata sine ullo dubio a *L. linearis* forma in Australia pervulgata sat abhorret, sed exstant formæ, quæ utramque varietatem conjungere videntur.

Lindsæa trilobata, Colenso, sistit secundum specimen authenticum tantum varietatem *L. linearis* et haud est specifice separanda.

CHEILANTHES, *Swartz*.

C. TENUIFOLIA, *Swartz*, var. NUDIUSCULA (*R. Br.*), f. *transiens*; segmentis latis rotundatis sed pinnis inferioribus sæpe subpinnatis.

W. Australia: Warrungup Hill, Stirling Range, coll. A. A. Dorrien-Smith, 1909.

ASPLENIUM, *Linn.*

A. FLABELLIFOLIUM, *Cav.* (Bentham, vii. 745).

W. Australia: Warrungup Hill, Stirling Range, coll. A. A. Dorrien-Smith, 1909.

A. FURCATUM, *Thunb.* (Bentham, vii. 747).

W. Australia: Mallet, collegit A. A. Dorrien-Smith, 1909.

Forma rhachi glabra vel paleis perpaucis instructa insignis.

GYMNOGRAMME, *Desv.*

G. RUTIFOLIA, *Hook.* (= *Grammitis rutifolia*, R. Br., Bentham, vii. 775.)

W. Australia: Warrungup Hill, Stirling Range, coll. A. A. Dorrien-Smith, 1909.

Forma frondibus parvis cum petiolis circa 4 cm. longis simpliciter pinnatis apice tantum pinnatilobis excellens.

EXPLANATION OF THE PLATES.

PLATE 10.

Fig. 1. *Neurachne Clementii*, Domin: a spike-like panicle (2 × enlarged)
2. ,, ,, ,, : first glume.
3. ,, ,, ,, : second glume.
4. ,, ,, ,, : third glume.
5. ,, ,, ,, : flowering glume with palea.
6. ,, ,, ,, : caryopsis. (All enlarged.)
7. *Panicum australiense*, Domin (natural size).

PLATE 11.

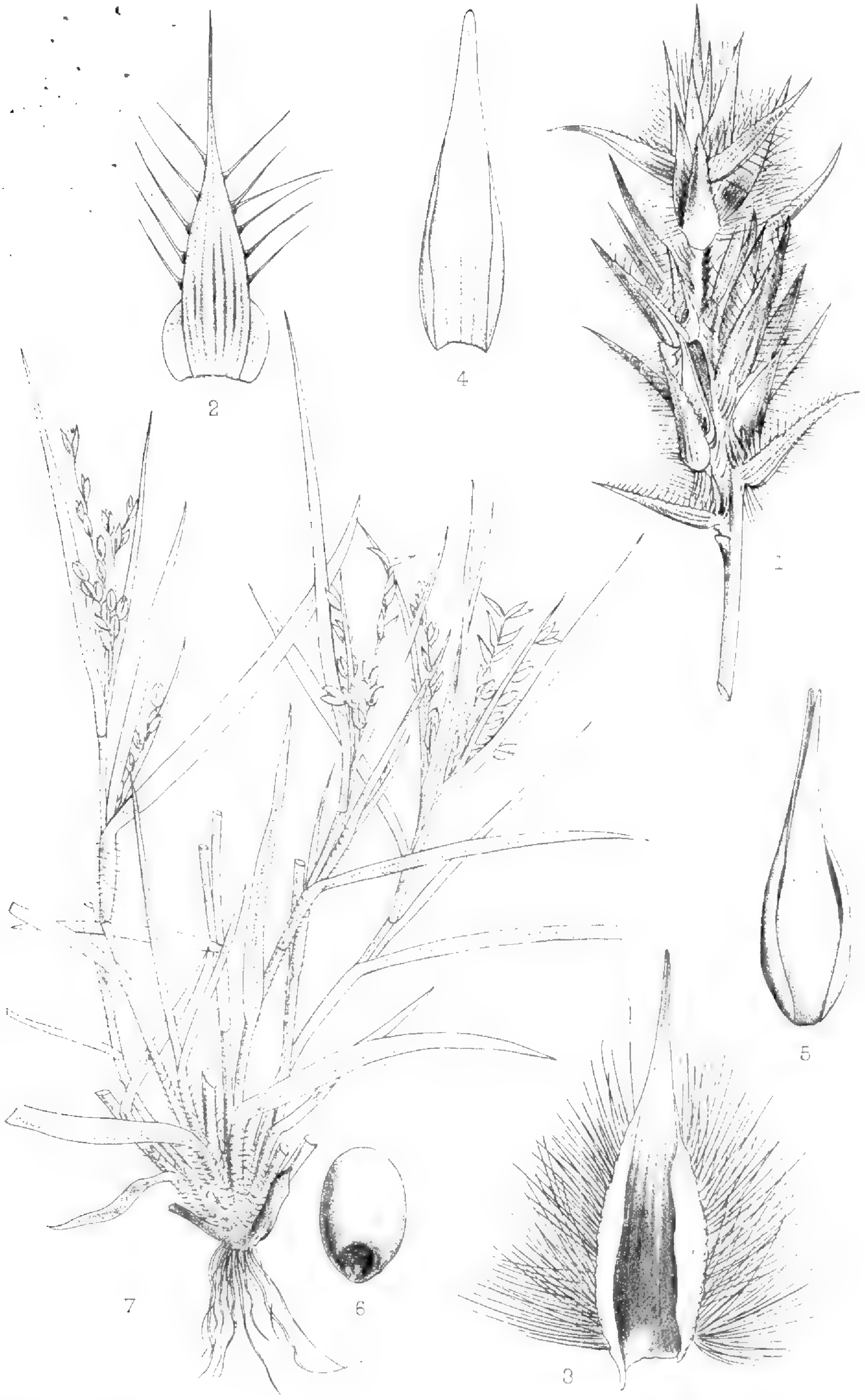
Fig. 8. *Panicum australiense*, Domin: hair on the leaf-sheath (enlarged).
9. ,, ,, ,, : a spikelet (10 × enlarged).
10. ,, ,, ,, : first glume.
11. ,, ,, ,, : flowering glume.
12. ,, ,, ,, : caryopsis.
13. *Sporobolus australasicus*, Domin: a spikelet (enlarged).
14. *Eriachne tuberculata*, Domin (natural size).
15. ,, ,, ,, : a spikelet (10 × enlarged).
16. ,, ,, ,, : flowering glume.
17. ,, ,, ,, : a hair from the leaf (enlarged).

PLATE 12.

Fig. 18. *Eragrostis xerophila*, Domin (natural size).
19. ,, ,, ,, : spikelet (12 × enlarged).
20. ,, ,, ,, : flowering glume with palea.
21. *Fimbristylis cardiocarpa*, F. Muell.: nut (enlarged).
22. *Anigozanthos Gabrielæ*, Domin: flower, 2½ × enlarged, without indument.
23. *Caladenia Dorrienii*, Domin (natural size).

PLATE 13.

Fig. 24. *Chamæscilla spiralis*, F. Muell. (natural size).
25. *Casuarina Dorrienii*, Domin: a branch with female flowering cones (enlarged).
26. ,, ,, ,, : a ripe cone (2 × enlarged).
27. ,, ,, ,, : a seed (7 × enlarged).



Domin & Obenberger del.
J. N. Fitch lith.
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WEST AUSTRALIAN PLANTS.

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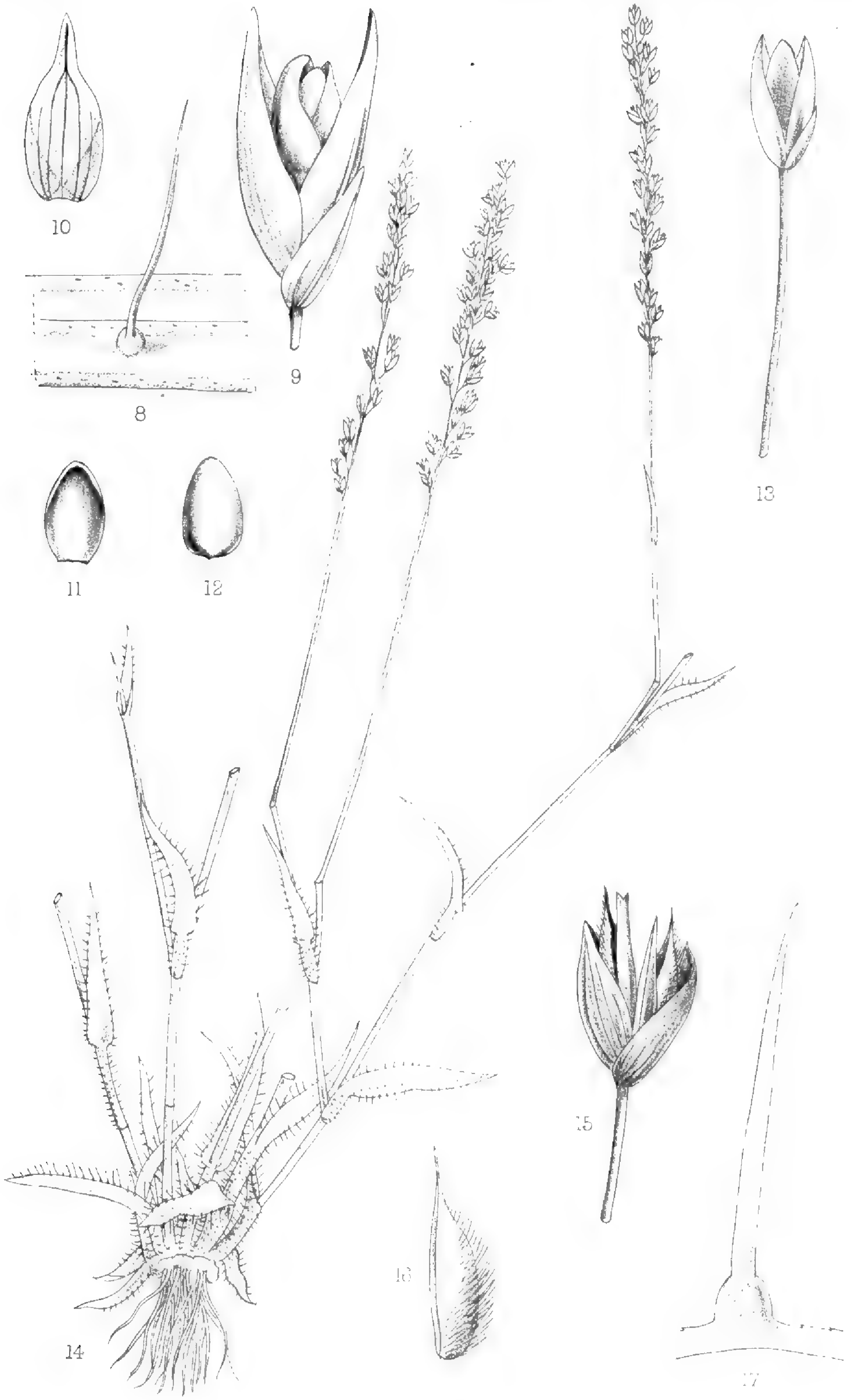

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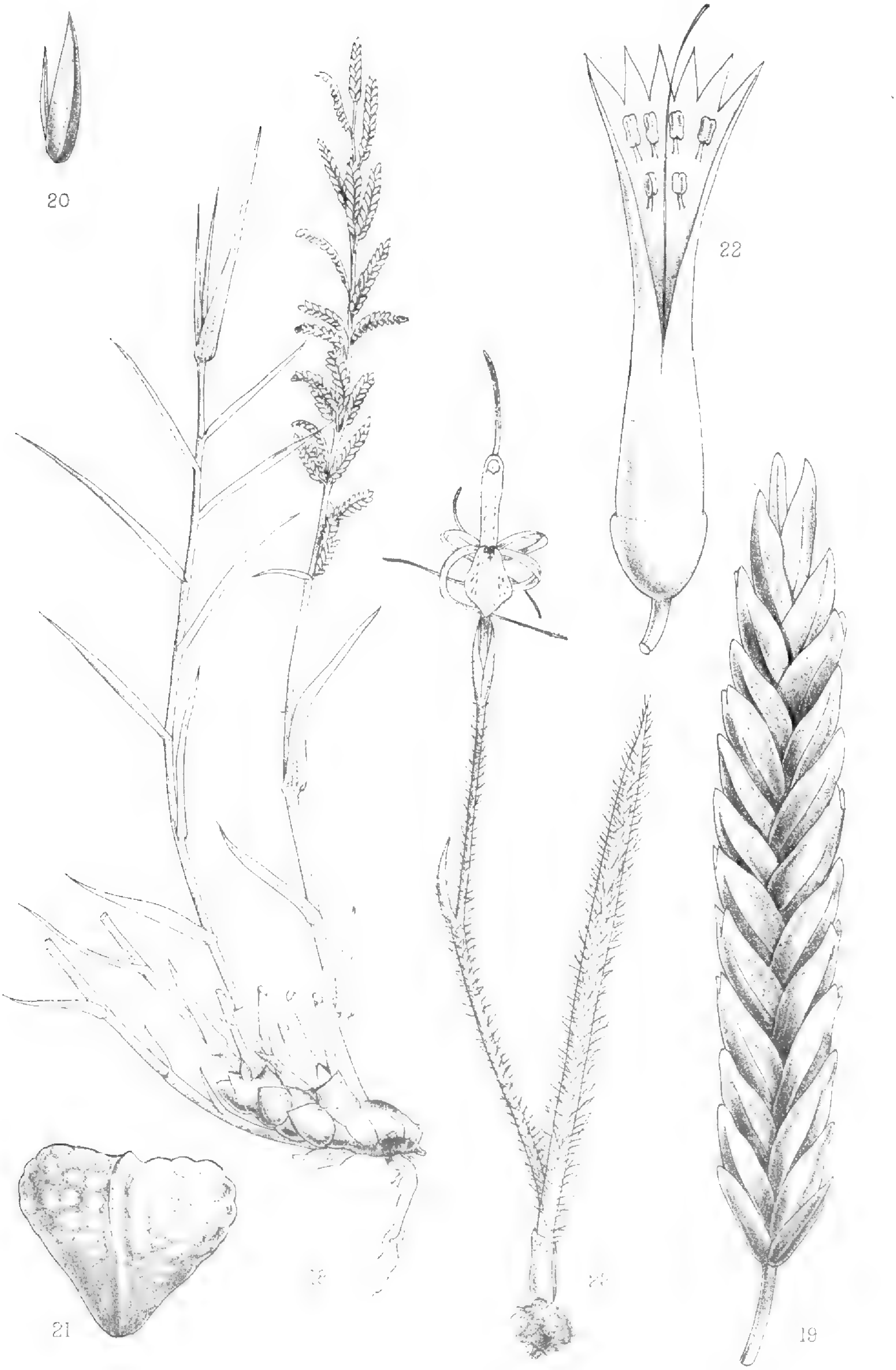

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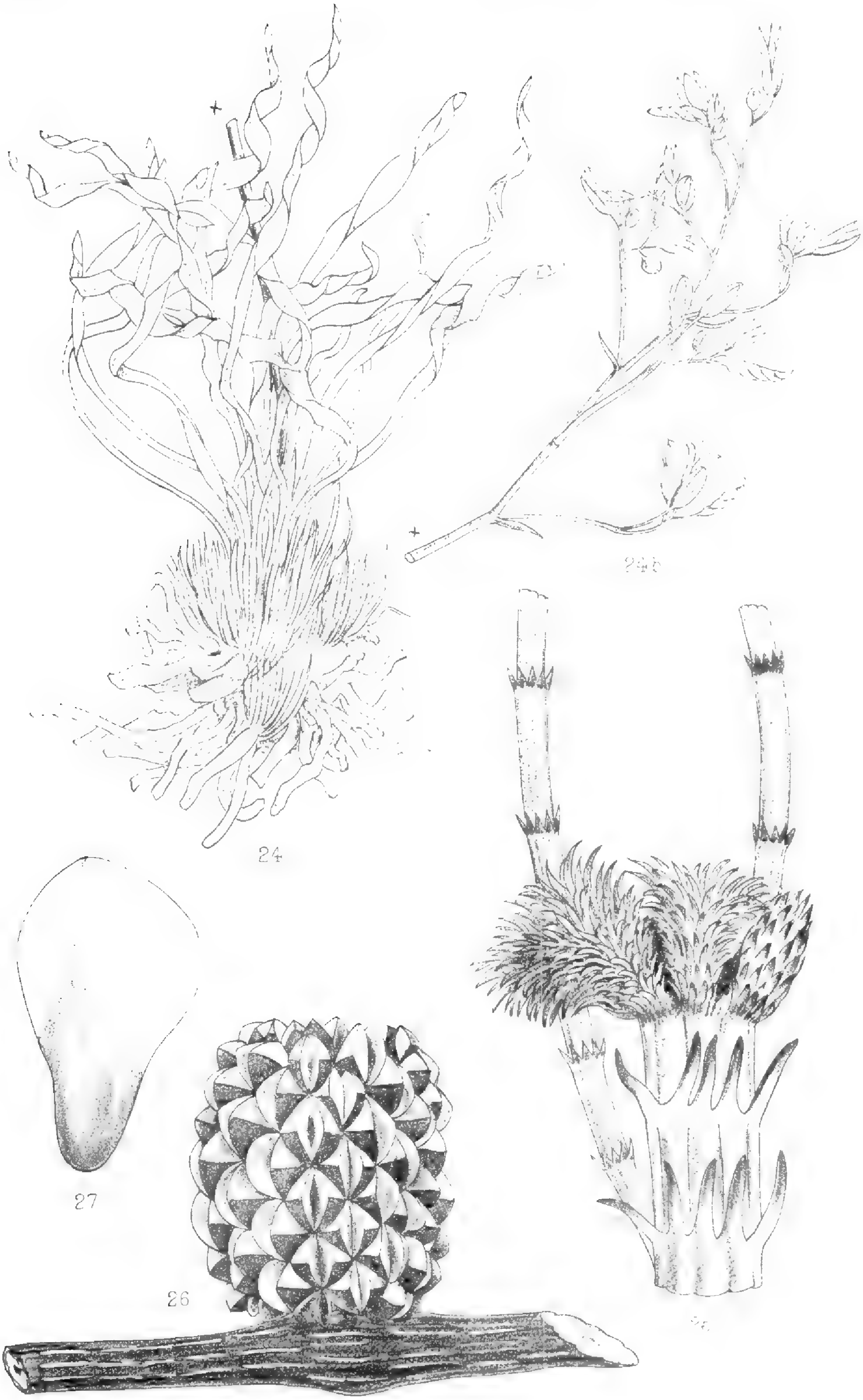

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An Expedition to Mount Mĕnuang Gasing, Selangor. By HENRY N. RIDLEY, F.R.S., F.L.S.; with an account of the Journey by C. B. KLOSS.

[Read 7th November, 1912.]

[MOUNT MĔNUANG GASING is 'Bukit Nyor' or 'Nuang' of local maps, one of the peaks of the range which forms the backbone of the Federated Malay States, and is situated within a mile of the spot where the boundaries of the States of Selangor, Perak, and the Negri Sembilan meet. It is 4908 feet in height, and though separated on the north from the more massive portions of the main range by passes of 2000 feet or so, it yet possesses a true mountain fauna: south of it the range becomes gradually broken up into more or less isolated groups of hills, few of which attain an equal altitude; while only to those in the immediate neighbourhood is the high-level fauna known to extend.

The summit of Mĕnuang Gasing itself is a somewhat steep peak rising above hills of only slightly inferior altitude.

The collection, of which Mr. Ridley treats below, was made in the course of a four or five days' visit in February 1912. At 6 o'clock one morning I left Dusun Tua (in the Ulu Langat district of Selangor, 17 miles from Kuala Lumpor), which is a rest-house near some hot springs impregnated with sulphuretted hydrogen, and at 5.45 P.M. made camp on a hill-side 2950 feet high. The day's march had been an extremely hard one (owing to the many descents we had to make before finally attaining this altitude), and we all arrived thoroughly exhausted, but I felt little compunction in getting the utmost out of the Sakais who acted as carriers, since they had refused to remain with me for more than one night, and had stood out for most extortionate remuneration.

Our palm-leaf shelter was made on the mountain-side on a flat knoll which the Sakais called Bukit Pengaseh, and even at that moderate altitude we found the nights extremely cold owing to the presence of a strong wind which blew uninterruptedly across the ridge; at midday the thermometer generally indicated about 70°.

Save for the occurrence of "Job's Tears" (*Coix Lachryma Jobi*) at 1350 feet, and the commencement of the Giant Bamboo zone at 2000 feet, I noted little of botanical interest, as, after leaving the various streams which form the sources of the Langat River, attention was principally directed to a search for water. I remember, however, a most unexpected show of Cannas in a Sakai clearing at 1000 feet.

The collection was made between the camp and the top of Mĕnuang

Gasing, about 3½ hours distant to the N.W. along a very undulating track, which ran up and down hill-sides, along ridges, and over many minor summits, but nowhere reached as low a level as Bukit Pengaseh.

In two spots some distance apart, but both at an altitude of 4100 feet, a yellow Balsam (*Impatiens oncidioides*) occurred, thickly covering swampy patches on the ridges, while I have rarely seen denser draperies of moss at a height of 4300 feet than on a rocky hill-top covered with trees whose roots crawled over the surface ; here orchids were numerous. At this height also we discovered a swamp and small pond on a level ridge which was deep in mud all along its length. Much of this mud was covered by a small-leaved creeping plant (*Pratia begoniæfolia*) which bore immense numbers of round pinkish-red fruits.

The ridges struck me as being unusually swampy, but the summit of Mĕnuang Gasing itself was quite dry, being of conical form ; it had been cleared some years previously, and was covered principally with myrtles, pitcher-plants, and long grasses.

It will be seen that the plants obtained occurred at altitudes between 3000 feet and 4908 feet.—C. B. K.]

The Flora.

The collection of plants made by Mr. Kloss on this expedition and described below, shows clearly the fact that this mountain, possessing as he states a high-level fauna, bears also a high-level flora.

The mountain itself possesses an interest in that it is one of the most southern ones of anything like that altitude in the peninsula, and the flora we find thereon is shown by this collection to be similar to that of the central mountain chain running to the northern part of the peninsula. This is illustrated by the occurrence here of such plants as the beautiful Golden Balsam *Impatiens oncidioides*, *Bucklandia populnea*, the rare *Polyosoma parviflora*, *Pratia begoniæfolia*, *Dilochia Cantleyi*, and *Goodyera gracilis*.

Further south we have one mountain of approximately the same height, viz. Mount Ophir, 4000 feet in altitude, the flora of which is now well known and is very different from that of the main chain and of Mĕnuang Gasing. Indeed, there is every evidence that Mount Ophir was never connected with the main chain of the peninsula, or at least not during the period of the evolution of the flora now found on the mountains of the central main range.

The novelties and additions to our flora are mostly of peninsular types, but of more special interest are the Javanese Orchid, *Physurus humilis*, *Forrestia glabrata* (Indo-Malaya), and the Indian *Pratia begoniæfolia*, which, however, was recently obtained on Gunong Kerbau in Perak; while among the new species, *Oberonia grandis*, probably the biggest species in this large genus, the remarkable *Blastus pulverulentus*, and the new *Balanophora* are the most noteworthy.

List of Plants collected.

POLYPETALÆ.

MAGNOLIACEÆ.

ILLICIUM CAMBODIANUM, *Hance, in Journ. Bot.* xiv. (1876) 240.

The flowers rather smaller than usual, and the petals not ciliate on the edge.

Distrib. Common on all the hills at about 4000 feet elevation.

ANONACEÆ.

GONIOTHALAMUS CURTISII, *King, in Journ. As. Soc. Beng.* lxi. (1892) ii. 75 (*Mat. Fl. Mal. Pen.* i. 324).

Distrib. Selangor and Perak.

UNONA FILIPES, *Ridl.*, n. sp.

Arbor 10–12-pedalis, glabra, cortice nigro. *Folia* elliptica, acuta, basibus rotundatis, tenuiter coriacea, superne viridia, subtus glauca, 19 cm. longa, 8 cm. lata, nervorum 15 paribus, petiolis 1 cm. longis. *Flores* singuli, axillares, kermesini vel brunnei, pedicellis filiformibus ad 38 cm. longis. *Sepala* parva, deltoideo-ovata, acuta, 3 mm. longa. *Petala* elongata, linearia, a basi latiore acuminata, ad apices spiraliter torta, angustissima, 15 cm. longa, ad basin 9 mm. lata. *Stamina* antheris oblongis apicibus late triangulari-ovatis. *Pistilla* lageniformia, dense pilis rufis tecta. *Carpella* matura ellipsoidea, 8 mm. longa, 5 mm. lata, brevissime apiculata, stipitibus 1 cm. longis.

Also in Perak (*Scortechini*, 342); Larut, 2500 to 3000 feet alt., 10 to 20 feet tall: flower brown, fruit glossy-green with brown tinge (King's Collector, 5291). Hill garden, medium-sized tree, flowers crimson (*Wray*, 609).

This plant is identified by King (Mat. Fl. Mal. Pen. i. 295) with *U. longiflora*, Roxb., a native of Assam and Chittagong. His description in this article and the description and figure in the 'Annals of the Calcutta Garden,' vol. iv. I. p. 58, pl. 80, do not apply to the Perak plant, which appears to me to be a very distinct species. It differs in its very much longer and more slender pedicels, which in *U. longiflora* vary from 1½–8 inches in length and are much stouter; in its petals, which are much narrower, narrowing rather abruptly from a broader base into a long filiform point, whereas in *U. longiflora* they are gradually narrowed and linear lanceolate, much broader and only 9 cm. long or little more; in the carpels, which in *U. longiflora* are often moniliform, with the joints elongate and much longer in proportion to their breadth than in *U. filipes*.

POLYALTHIA MONTANA, *Ridl.*, n. sp.

Arbor ramis tenuibus, cortice nigro, partibus junioribus pilis flavescentibus appressis tectis. *Folia* lanceolata, acuminata, apicibus obtusis, basibus brevius acuminatis, coriacea, nitida, subtus pallidiora, glabra, 15 cm. longa, 45 mm. lata, nervorum paribus 8, reticulationibus conspicuis tenuibus, petiolis pubescentibus 5 mm. longis. *Flores* extra-axillares, singuli, 1 cm. lati, pedicellis 1 cm. longis. *Sepala* parva, ovata, hirta. *Petala* oblonga, ovata, extus hirta, intus glabra, obtusa, serie externa quam interiore breviore. *Stamina* oblonga, connectivo subelliptico, apice canaliculato antheram vix tegente. *Ovaria* pauca, oblonga, hirta, stigmatibus glabris. *Ovulum* singulum. *Carpella* matura ellipsoidea, hirta vel pilis dejectis pustulata, 1 cm. longa, stipitibus 3 mm. longis.

Distrib. Ulu Langat (*C. B. Kloss*).

Nearest to *P. dumosa*, King, but differing in the venation of the leaves, the petals hairy outside and glabrous within, the connective or appendage of the stamen smaller, somewhat oblong, grooved along the top, and in the form of the fruit. Most of the flowers on the specimens appear to be unisexual and male, having no pistils. The petals appear to have been purple.

POLYGALACEÆ.

POLYGALA VENENOSA, *Juss. in Poir. Dict. Encyc.* v. 493.

There are two forms in the collection, one the common peninsular form with broad ovate leaves, the other with oblanceolate leaves.

Distrib. Common in the hill-woods above 1000 feet elevation.

STERCULIACEÆ.

LEPTONYCHIA GLABRA, *Turcz. in Bull. Soc. Nat. Mosc.* xxxi. (1858) 222.

Distrib. Common all over the Peninsula.

RUTACEÆ.

GLYCOSMIS PENTAPHYLLA, *Correa, in Ann. Mus. Par.* vi. (1804) 384.

Distrib. Common all over the Peninsula.

GERANIACEÆ.

IMPATIENS ONCIDIOIDES, *Ridl. in Kew Bull.* (1909) 11.

Distrib. This beautiful Balsam seems to be abundant here. It occurs also in Perak and other parts of Selangor.

MELIACEÆ.

AGLAIA ODORATISSIMA, *Blume, Bijdr.* 171.
Distrib. Common in the Peninsula and Sumatra and Java.

CELASTRINEÆ.

GLYPTOPETALUM QUADRANGULARE, *Prain, ex King in Journ. As. Soc. Beng.* lxv. II. (1895) 345.
Distrib. Singapore to Perak.

SAPINDACEÆ.

ALLOPHYLUS COBBE, *Blume, Rumphia*, iii. 131.

Var. GLABRA. In this form the leaflets are lanceolate to ovate-lanceolate, acuminate at both ends, entire, cuneate at the base, smooth, shining and papery when dry; the petioles, petiolules and rhachis of the inflorescence covered with short stiff hairs; the flowers rather more scattered on the rhachis than usual; the bracts short and the petals fringed with white hairs. I have seen no form exactly like it.

HAMAMELIDEÆ.

BUCKLANDIA POPULNEA, *R. Br. Wall. Cat.* n. 7414.
Hills of Pahang and Perak.
Distrib. Himalayas, Burma, Java, Sumatra.

SAXIFRAGACEÆ.

POLYOSMA PARVIFLORA, *King, in Journ. As. Soc. Beng.* lxvi. (1898) II. 300.

I have examined the co-type of this species in the Herbarium at Kew, a plant collected by Wray on Gunong Inas, in Perak. It is in young bud, and I have little doubt that the plant collected by Kloss on Mĕnuang Gasing is the same in spite of some differences in the original description. King describes the calyx-tube as narrow and nearly glabrous; but in the type it is distinctly hairy. He gives the flowers as 0·2 inch long. In Kloss's plant, where they are fully open, they are just twice as long, and nearly glabrous, and the petals hardly as long as the anthers. These differences are due no doubt to the young state of Wray's plant.

Distrib. Hitherto only known from Gunong Inas.

MELASTOMACEÆ.

SONERILA TENUIFOLIA, *Blume, in Flora*, xiv. (1831) 491.
Distrib. Common in the hills of the Peninsula, Sumatra, Java, and Borneo.

BLASTUS PULVERULENTUS, *Ridl.*, n. sp.

Frutex ramis tenuibus. *Folia* ovata, acuminata, basibus cuneatis, superne glabra, 13 cm. longa, 7 cm. lata, stellatim lepidota et glandulis copiosis munita, subtus nervis prominulis 3 ad basin connatis, petiolis 25 mm. longis. *Cymæ* axillares vel subterminales, 3 cm. longæ, paucifloræ. *Bracteæ* lineares, 3 mm. longæ. *Flores* parvi, pedicellis 3 mm. longis. *Calycis* tubus subglobosus, lobis brevibus ovatis 4. *Petala* 4, ovata vix longiora, glabra. *Stamina* 4 æqualia et similia, filamentis petala æquantibus, antheris longioribus curvis acuminatis, basi processibus 2 brevibus obtusis munita. *Stylus* breviusculus, basi stellato-pilosus.

Distrib. Ulu Langat (*C. B. Kloss*).

This species is very different in appearance from our common *Blastus Cogniauxii*, Stapf, both in habit and larger flowers, and more resembles an *Anerincleistus*, but the four similar and equal stamens distinguish it from that and allied genera.

MEDINILLA CLARKEI, *King, in Journ. As. Soc. Beng.* lxix. (1900) II. 63.

Distrib. Common on hills from 3000 to 5000 feet elevation. Malacca, Perak, Selangor.

MEDINILLA HULLETTII, *King, l. c.* 76.

Distrib. Also occurs in Johor.

BEGONIACEÆ.

BEGONIA MEGAPTEROIDEA, *King, l. c.* lxxi. (1902) II. 65.

Distrib. Perak.

BEGONIA KLOSSII, *Ridl.*, n. sp.

Rhizoma validum, repens, elongatum, lignosum. *Folia* longe petiolata, ovata, subabrupte acuminata, basibus rotundatis æquilateralibus, integra, 11·3 mm. longa, 5–6 cm. lata, in dorso furfuracea, aliter glabra, nervorum paribus 5 gracilibus, petiolis gracilibus 18 cm. longis. *Pedunculus* e rhizomate erectus, subtenuis, ruber, 0·15 cm. longus, squamis lanceolatis acuminatis obtectus. *Flores* masculi 3–4, in pedicellis gracilibus 2 cm. longis. *Bracteæ* 2, lanceolatæ, persistentes, 1 cm. longæ. *Sepala* oblonga, subspathulata, apicibus rotundatis, 14 mm. longa, 5 mm. lata. *Petala* angustiora et breviora. *Andrœcium* sessile, filamentis gracilibus, dimidio antheræ æquilongis, antheris linearibus obtusis haud apiculatis. *Capsula* trialata, ala una longiore oblonga oblique rotundata, ad apicem 2 cm. longa 1 cm. lata, alis obtuse triangularibus 5 mm. longis.

The flowers apparently white. This is allied to *B. Robinsonii*, Ridley; but the leaves are quite equilateral and not bilobed. It evidently creeps on tree trunks as does that species, as one specimen shows roots spread out from the rhizome with moss on them.

ARALIACEÆ.

BRASSAIOPSIS ELEGANS, *Ridl.*, n. sp.

Frutex cortice griseo, partibus junioribus tomento rufo-tectis. *Folia* digitata vel simplicia, foliolis lanceolatis acuminatis, basibus longe angustatis, marginibus minute denticulatis, herbacea, subtus pallidiora, 16 cm. longa, 4–5 cm. lata, nervorum 5 paribus, petiolulis 3 cm. longis, petiolis 13 cm. longis gracilibus. *Stipulæ* connatæ, latæ, bidentatæ, dentibus acuminatis. *Panicula* longa, laxa, deflexa, gracilis, pedunculo gracili 10 cm. longo cum ramis 4–12 cm. longis rufo-tomentoso, umbellis 1 cm. longis 13-floris, pedicellis florum 5 mm., fructuum 1 cm. longis. *Bracteæ* lanceolatæ, acuminatæ, 3 mm. longæ, umbellares breviores apicibus brevioribus, omnes rufo-tomentosæ. *Calyx* obconicus, dentibus brevibus rufo-tomentosus. *Petala* 5, oblonga, obtusa, parce hirta. *Stamina* 5, brevia, filamentis brevibus, antheris oblongis obtusis. *Stylus* unicus, brevis, crassus, in flore quam stamina brevior, stigmate capitato. *Discus* pulviniformis. *Ovarium* biloculare.

Distrib. Ulu Langat.

This species is allied to *B. speciosa*, DC. & Planch., but is very distinct in its much smaller, more slender inflorescence, and longer peduncles.

RUBIACEÆ.

ADENOSACME LANCEOLATA, *Ridl. in Journ. Fed. Mal. States Mus.* iv. (1909) 29.

Distrib. Also in Pahang.

ARGOSTEMMA INVOLUCRATUM, *Hemsl. in Hook. Ic. Pl.* t. 1556.

Distrib. Perak, Pahang.

ARGOSTEMMA SPINULOSUM, *Clarke, in Hook. f. Fl. Brit. Ind.* iii. 46.

Distrib. Also Perak.

ARGOSTEMMA HOOKERI, *King, in Journ. As. Soc. Beng.* lxxii. (1903) II. 155.

Distrib. Also Johor, Penang.

OPHIORRHIZA ERUBESCENS, *Wall. Cat.* n. 6233.

Distrib. Burmah, Perak.

OPHIORRHIZA KLOSSII, *Ridl.*, n. sp.

Herba pedalis (30 cm. alta), caule validulo basi glabro, superne velutino-pubescente. *Folia* ovata vel oblongo-lanceolata, acuminata, apice obtusa, basi acuminata, glabra nervis in dorso pubescentibus exceptis, superne viridia, subtus pallida, 115 mm. ad 15 cm. longa, 43 mm. lata, nervorum paribus ad 14 in nervum submarginalem junctis, petiolis pubescentibus 35 cm. longis. *Stipulæ* lineares, 5 mm. longæ. *Cymæ* compactæ, nutantes, deflexæ, pubescentes, 1 cm. longæ. *Bracteæ* persistentes, lineares, dimidio pedunculi æquales. *Pedicelli* breves, pubescentes, ovario breviores. *Calyx* globoso-cupulatus, pubescens, lobis 5 ovatis acutis dimidio tubi æquantibus. *Corolla* tubulosa, crassiuscula, 6 mm. longa, glabra, apicibus paullo pubescentibus exceptis, lobis obtusis ¼ tubi æquantibus. *Stamina* 5, glabra, quam corolla breviora, antheris linearibus. *Stylus* longior, stigmate bifido. *Capsula* obreniformis, sinu lato profundo, pubescens, 8 mm. lata, ad sinum 1 mm. alta.

A very distinct species in its rather large flowers in the nodding head, the persistent bracts and the broad linear stipules.

KLOSSIA MONTANA, *Ridl. in Journ. Fed. Mal. States Mus.* iv. (1909) 28.
Distrib. Selangor and Pahang.

WEBERA PULCHRA, *Ridl. l. c.* 33.
The leaves are rather smaller than in the type.
Distrib. Pahang.

IXORA KINGSTONI, *Hook. f. Fl. Brit. Ind.* iii. 140.
Distrib. Johor, Selangor, Perak, Malacca, and Andamans.

PAVETTA INDICA, *Linn. Sp. Pl.* 110.
Distrib. Whole Peninsula.

LASIANTHUS WIGHTIANUS, *Hook. f. Fl. Brit. Ind.* iii. 188.
Distrib. Mt. Ophir.

LASIANTHUS FLAVICANS, *King & Gamble, in Journ. As. Soc. Beng.* lxxiii. (1904) II. 116.
Distrib. Singapore, Pahang, Perak, and Selangor.

PSYCHOTRIA STIPULACEA, *Wall. in Roxb. Fl. Ind. ed. Carey*, iv. 164.
Distrib. Common over the whole Peninsula.

COMPOSITÆ.

GYNURA SARMENTOSA, *DC. Prodr.* iv. 298.
Distrib. Whole Peninsula, Siam, and Malaya.

ADENOSTEMMA VISCOSUM, *Forst. Char. Gen.* 20.
Distrib. Common, especially in hill-districts.

CAMPANULACEÆ.

PRATIA BEGONIÆFOLIA, *Lindl. Bot. Reg.* t. 1373.

Distrib. Only previously met with in Gunong Kerbau in Perak, and in India.

VACCINIACEÆ.

VACCINIUM BREVIFLOS, *Ridl.*, n. sp.

Frutex. *Folia* coriacea, oblanceolata, versus apicem abrupte acuminatum latiora, ad basin angustata, 4 cm. longa, 2 cm. lata, glabra, superne pallida, subtus brunnea (in sicca), nervis 6 ascendentibus, petiolis 4 mm. longis. *Racemi* axillares et subterminales, breves, 2 cm. longi vel minores, rachi et pedicellis pubescentibus, ad bases floriferi. *Bracteæ* ovatæ, subacutæ, 4 mm. longæ. *Calyx* cupuliformis, margine integro. *Corolla* extus glabra, cylindrica, lobis brevissimis recurvis rotundatis, 5 mm. longa. *Stamina* breviora 10, filamentis brevibus hirtis. *Antheræ* parvæ, oblongæ, rostris oblongis truncatis ferme æquilongis parallelis, processibus basalibus nullis. *Stylus* crassiusculus, ad basin hirtus, superne glaber, quam corolla brevior, stigmate capitato. *Discus* pulviniformis.

This species somewhat resembles *V. Kunstleri*, but is in all parts much smaller.

MYRSINEÆ.

LABISIA PUMILA, var. ALATA, *Scheff. Myrs.* 93.

Distrib. Common in the Peninsula, Borneo, and Sumatra.

ARDISIA ANDAMANICA, *Kurz, For. Fl.* ii. 108.

Distrib. Andamans and Mergui, south to Johor.

STYRACEÆ.

SYMPLOCOS SPICATA, var. MALASICA, *C. B. Clarke, in Hook. f. Fl. Brit. Ind.* iii. 573.

Distrib. Malacca and Perak.

OLEACEÆ.

JASMINUM ADENOPHYLLUM, *Wall. Cat.* n. 2876.

Distrib. Apparently a rare plant, only obtained in the Khasiya hills (Wallich) and by Kunstler in Penang.

APOCYNACEÆ.

RAUWOLFIA PERAKENSIS, *King & Gamble, in Journ. As. Soc. Beng.* lxxiv. (1908) II. 424.

Distrib. Perak and Pahang.

ASCLEPIADEÆ.

Dischidia coccinea, *Griff. Notul.* iv. 45.
Distrib. Malacca, Perak.

Dischidia acutifolia, *Maing. ex Hook. f. Fl. Brit. Ind.* iv. 51.
Distrib. Malacca.

GESNERACEÆ.

Agalmyla staminea. *Blume, Bijdr.* 767.
Distrib. Hills of the Malay Peninsula, Java, Sumatra.

Æschynanthus longicalyx, *Ridl. in Journ. Str. Br. As. Soc.* xliii. 16.
Distrib. Perak and Selangor.

Didymocarpus hispidus, var. selangorensis, *Ridl. apud King & Gamble, in Journ. As. Soc. Beng.* lxxiv. (1909) ii. 750.
Distrib. Selangor.

Cyrtandromæa acuminata, *Benth. & Hook. f. Gen. Pl.* ii. 1020.
Distrib. Malay Peninsula from Tringanu southwards to Selangor.

Cyrtandra pilosa, *Blume, Bijdr.* 770.
Distrib. Malay Peninsula to New Guinea.

ACANTHACEÆ.

Strobilanthes Maingayi, *C. B. Clarke, in Hook. f. Fl. Brit. Ind.* iv. 448.
Distrib. Penang, Perak, Selangor.

Pseuderanthemum lilacinum, *Stapf, in Bot. Mag.* t. 8446.
Distrib. Johor.

Pseuderanthemum parviflorum, *Ridl.*, n. sp.
Suffrutex, glaber. *Folia* late lanceolata, herbacea, utrinque acuminata, subtus pallida, 19 cm. longa, 7 cm. lata, nervorum 11 paribus, petiolis 1 cm. longis. *Panicula* 15 cm. longa, rachi pubescente. *Bracteæ* breves, 1 mm., lineares, acuminatæ. *Pedicelli* breves, vix 1 mm. longi. *Sepala* hirta, linearia, acuminata, 1 mm. longa. *Corolla* 1 cm. longa, crassiuscula, hirta, versus medium gradatim dilatata; labium superius lanceolatum, apice bifido, lobis lateralibus sublanceolatis angustioribus; labium inferius longius, carnosulum, lanceolatum, omnino parce hirtum. *Stamina* 2, antheris in dorso hirtis, loculis haud parallelis inæqualibus, basibus mucronulatis. *Stylus*

glaber. *Capsula* 3 cm. longa, pedicellata, apice magno dilatato acuto 7 mm. lato. *Semina* 4, complanata, rugosa.

Allied to *P. breviflos* (C. B. Clarke) Ridl., but differing in foliage and habit.

LEDA LANCIFOLIA, *Ridl.*, n. sp.

Suffrutex, cortice pallido. *Folia* lanceolata, acuminata, basibus longe cuneatis, æqualia, herbacea, 12 cm. longa, 5 cm. lata, superne glabra, subtus in nervis minute scabro-hirta, nervorum circiter 10 paribus tenuibus, petiolis 1 cm. longis. *Panicula* terminalis, 6 cm. longa, ramis paucis patulis, pauciflora. *Bracteæ* lineares, 4 mm. longæ. *Sepala* linearia, acuminata, acuta, 5 mm. longa, glabra. *Corolla* 15 mm. longa, lobis labii superioris lanceolatis, inferioribus obtusis, lobo medio pilis flavis munito. *Stamina* 2, antheris hirtis muticis subparallelis.

A single specimen with only one corolla remaining, but enough to show that the plant belongs to the genus *Leda*, as separated by C. B. Clarke, and that it is specifically distinct from any other species. The inflorescence is open and spreading, with a few branches and about 7 flowers on short pedicels 2–5 mm. long. The whole of the leaves and panicle dries black.

APETALÆ.

NEPENTHACEÆ.

NEPENTHES GRACILLIMA, *Ridl. in Journ. Linn. Soc., Bot.* xxxviii. (1908) 320.

Apparently a large-sized form of this species, but without flowers.

Distrib. Pahang and Selangor.

PIPERACEÆ.

PIPER MAGNIBACCUM, *C. DC. in Records Bot. Surv. Ind.* vi. 5.

Distrib. Perak.

PIPER CANINUM, *Blume, in Verh. Batav.-Gen.* xi. (1826) 214. f. 26.

The pubescent form, with ovate nearly cordate leaves.

Distrib. Common all over the Peninsula.

PIPER MURICATUM, *Blume, Cat. Gew. Buitenz.* 33.

Distrib. Common in forest in the Peninsula.

CHLORANTHACEÆ.

CHLORANTHUS BRACHYSTACHYS, *Blume, Fl. Jav. Fasc.* viii. 13, 14.

Distrib. Common on hills, India, China, and Malaya.

MYRISTICACEÆ.

MYRISTICA CANTLEYI, *Hook. f. Fl. Brit. Ind.* v. 110.

A large-leaved, nearly glabrous form.

Distrib. Malay Peninsula.

LAURACEÆ.

LITSEA CINERASCENS, *Ridl.*, n. sp.

Arbor, cortice ramulorum pallide griseo. *Folia* lanceolata, acuminata, basibus attenuatis obtusis, alterna vel subopposita, tenuiter subcoriacea, superne glabra, subtus cinerea, 21 cm. longa, 5–6 cm. lata, costa nervisque 11-jugatis minute rufo-tomentosis, petiolis crassiusculis tomentosis 5 mm. longis. *Flores* feminei in pedunculis brevissimis, 2 mm. longis, bracteis ovatis lanceolatis tomentosis minimis. *Pedunculi* umbellarum tomentosi, 4–5 mm. longi. *Bracteæ* involucrales 4, ovatæ, acutæ, extus sericeæ. *Umbellulæ* 3 in pedunculis crassiusculis sericeis, 3 mm. longæ. *Sepala* 6, oblonga, obtusa, extus sericea. *Staminodia* exteriora 6, filamentis longiusculis sericeis, antheris abortivis, interiora 3-breviora, exterioribus ad bases adnata, spathulata, glandulis reniformibus 2 ad basin sessilibus. *Ovarium* parvum, ovoideum, glabrum. *Stylus* filiformis, stigmate peltato-discoideo sublobato. *Flores* masculi et fructus non visi.

Distrib. Also met with at Telom, Pahang (*Ridley*, 13781).

Litsea cinerascens seems nearest to *Litsea amara*, Blume, but is much more glabrous than any form of this species, with fewer flowers in the umbels and larger leaves. Gamble, in the 'Materials for a Flora of the Malay Peninsula,' gives the Telom plant under the variety *attenuata* of *L. amara*, but it is very different from the other plants included under that variety, and should have at least a varietal name.

THYMELÆACEÆ.

DAPHNE PENDULA, *Sm. Ic. Ined.* ii. 34, t. 34.

Distrib. This pretty shrub is not rare in the hill woods of the Malay Peninsula, Burma and Malaya.

BALANOPHORACEÆ.

BALANOPHORA TRUNCATA, *Ridl.*, n. sp.

Rhizoma arcte pustulosum. *Folia* ad basin pedunculi 3, ovato-oblonga, apicibus rotundatis vel emarginatis, 5–15 mm. longa, 9–10 mm. lata, summa 2, oblonga, majora, truncata, 2 cm. longa, 1 cm. lata. *Pedunculus* masculus 7 cm. longus, basi ad 3 cm. nudus, 3 mm. crassus. *Flores* in spica dissiti, circiter 30, sessiles. *Alabastra* transversim oblonga. *Sepala* 2,

exteriora transverse oblonga, 4 mm. lata, multo breviora; interiora lineari-oblonga, apicibus incurvis, exterioribus æquilonga, 1 mm. lata. *Andrœcium* transverse oblongum, 3 mm. latum, antheris plurime dense congestis, serie una.

The solitary specimen in the collection is a male inflorescence with the leaves and a small part of the rhizome attached. It has no trace of female flowers, and evidently belongs to an unisexual species, such as *B. polyandra*, Griff., which, however, is a very much larger plant. It is quite distinct from this in the very unequal and dissimilar sepals, the upper and lower ones being much wider and quite truncate, with a long straight edge at the apex.

EUPHORBIACEÆ.

SAUROPUS FORCIPATUS, *Hook. f. Fl. Brit. Ind.* v. 334.
Distrib. Hill woods of the Malay Peninsula.

ANTIDESMA PENDULUM, *Hook. f. l. c.* v. 356.
Distrib. Perak.

URTICACEÆ.

ELATOSTEMMA ACUMINATUM, *Brongn. Bot. Voy. Coq.* 111.
Distrib. Not rare by mountain streams in the Peninsula.

FICUS SUBULATA, *Blume, Bijdr.* 460.
Distrib. Malay Peninsula and Islands.

ORCHIDEÆ.

OBERONIA (§ CAULESCENTES) GRANDIS, *Ridl.*, n. sp.

Caules plures, pedales. *Folia* ensiformia, curva, acuminata, 15–17 cm. longa, 15 mm. lata. *Spicæ* terminales, 15 cm. longæ, ad basin densifloræ, floribus flavidulis subverticillatis. *Bracteæ* lanceolatæ, cuspidatæ; pedicelli 1 mm. æquantes. *Sepala* ovata, acuta. *Petala* oblonga, lanceolata, integra, angustiora. *Labellum* oblongo-obovatum, apice bifido marginibus breviter denticulatis, fovea ovata. *Anthera* late ovata, subrostrata. *Capsula* 5 cm. longa, oblongo-globosa.

Ula Langat.

A very large-sized species, with stems a foot to 18 inches long or more including the spike, and with about six long curved leaves, scimitar-shaped. Spikes not very crowded, but flowering to the base. Flowers 2 mm. across, apparently yellow. The sepals short and broad, and the lip resembling that of *O. biaurita*, Hook. f.

LIPARIS FLACCIDA, *Reichb. f. in Linnœa*, xli. (1877) 45.
In fruit only.
Distrib. Siam, Malacca, Perak, Selangor, and Malay Islands.

LIPARIS COMOSA, *Ridl. in Journ. Linn. Soc., Bot.* xxxii. (1896) 229.
Distrib. Perak.

ERIA (§ DILOCHIOPSIS) SCORTECHINII, *Hook. f. Fl. Brit. Ind.* v. 809.
Distrib. Hills of Perak and Pahang, at about 4000 feet elevation.

PHREATIA (§ BULBOSÆ) LINEARIS, *Ridl.*, n. sp.

Rhizoma 4 cm. longum, dense pseudobulbis et radicibus tectum. *Pseudobulbi* globoso-conici, 1 cm. longi. *Folia* 2–3 anguste linearia, obtusa, 11 cm. longa, 5 mm. lata, coriacea, basi in petiolum angustata. *Scapus* gracilis, 16 cm. longus, basi ad dimidium nudus, foliis caulinis circiter 4, lanceolatis acuminatis 10 mm. longis exceptis. *Flores* minimi, subremoti. *Bracteæ* anguste lanceolatæ, subulatæ, 2 mm. longæ. *Ovarium* cum pedicello longius quam bracteæ. *Sepala* ovata. *Petala* angustiora, oblonga, subacuta. *Labellum* ovatum, haud unguiculatum, integrum, obtusum, quam sepala brevius.

Ula Langat.

Very near, if not identical, is a plant collected by Beccari on Mt. Singalan, Sumatra, No. 397 (Herb. Kew.).

This plant most resembles *Ph. listrophora*, Ridl.; the lip is, however, not clawed but ovate, like that of *Ph. minutiflora*, Lindl.

CERATOSTYLIS GRACILIS, *Blume, Bijdr.* 306.
Distrib. Common all over the Peninsula.

CERATOSTYLIS LANCIFOLIA, *Hook. f. Fl. Brit. Ind.* v. 826.
Distrib. Apparently rare, having only previously been collected by Scortechini in Perak.

CALANTHE VERATRIFOLIA, *R. Br. in Bot. Reg.* sub t. 573.
Distrib. Johor and Perak, India, Malay Islands to Australia.

CŒLOGYNE CARNEA, *Hook. f. Fl. Brit. Ind.* v. 838.
Distrib. Pahang, Selangor, Perak. Common at high altitudes.

DILOCHIA CANTLEYI, *Ridl. in Journ. Linn. Soc., Bot.* xxxii. (1898) 332.
Distrib. Perak and Pahang, at high altitudes.

PLOCOGLOTTIS JAVANICA, *Blume, Bijdr.* 381, t. 21.
Distrib. Common all over the Peninsula, Java.

SACCOLABIUM BIGIBBUM, *Hook. f. Bot. Mag.* 5767.
Distrib. Burmah, Perak, and Pahang.

THRIXSPERMUM MONTANUM, *Ridl.*, n. sp.

Caulis validus, 15 cm. longus, 6 mm. latus. *Folia* coriacea, lorata, obtusa, 15 cm. longa, 2 cm. lata. *Pedunculus* 45 mm. longus. *Racemus* 15 mm. longus, pauciflorus, vix incrassatus, compressus, bracteis ovatis acutis. *Flores* ad 7, pedicellis 4 mm. longis. *Sepala* oblonga, lanceolata, subacuta, 6 cm. longa, 4 cm. lata. *Petala* angustiora, lanceolata, subfalcata. *Labellum* saccatum, unguiculatum, lobis vix distinctis brevibus truncatis, lobo medio rotundato brevi, calcare conoideo porrecto obtuso. *Columna* brevis, lata, clinandrio late ovato, rostelli lobis brevibus obtusis. *Anthera* ovata, rostro lato truncato-quadrato, polliniis oblongis obtusis, stipitibus brevibus, disco minuto ovato.

Ulu Langat.

Not very like any species known to me. The lip has a saccate base and the margins are elevated, ending in two short blunt points representing the side lobes; between these at the end is a short rounded lobe representing the mid-lobe, the spur is conic as in *Th. Calceolus.* The pollinia seem to be sausage-shaped rather than pyriform. The clinandrium is large for the flower, with distinct thick projecting margins.

PODOCHILUS LANCIFOLIA, *Schlecht. Mon. Pod.* 12.
Distrib. Selangor and Perak.

GOODYERA GRACILIS, *Hook. f. Fl. Brit. Ind.* vi. 112.
Var. UNICALLOSA, *Ridl.*, n. var.

Flores $\frac{1}{5}$ poll. longi. *Labellum* oblongum, cymbiforme, lobo terminali cordato-ovato, callo singulo oblongo, apice rotundato obtuso. *Anthera* longior, magis acuminata, polliniis elongatis pyriformibus, disco lineari ultra dimidium pollinii longo.

This has the exact habit of *G. gracilis,* Hook. f., a native of the upper part of the Larut Hills, near Gunong Hijau. I find, however, that the two calli in the base of the lip are connate into one blunt thick round-tipped organ, and that the pollinia are longer and narrower, with the linear disc more than half as long as the pollen-mass.

PHYSURUS HUMILIS, *Blume, Orchid. Arch. Ind.* 96, pl. 27. 2, 12–13.
A single specimen.
Distrib. New to the Malay Peninsula. Native of Java.

CRYPTOSTYLIS ARACHNITES, *Blume, Orch. Arch. Ind.* 132, t. 45.
Distrib. Common up to about 4000 feet in the Malay Peninsula, India Java, Ceylon.

HABENARIA ZOSTEROSTYLOIDES, *Hook. f. Fl. Brit. Ind.* vi. 155.
Distrib. Malacca, Perak, and Pahang.

HABENARIA GIGAS, *Hook. f. l. c.* 160.
Specimen in fruit only, and so doubtful.
Distrib. Perak.

SCITAMINEÆ.

Globba regalis, *Ridl. in Journ. Fed. Mal. States Mus.* iv. (1909) 74.
Base of stem blood-spotted.
Distrib. Pahang.

AMARYLLIDEÆ.

Curculigo latifolia, *Ait. Hort. Kew.* ed. 2, ii. 253.
Distrib. Burmah, Andamans, Malaya.

LILIACEÆ.

Peliosanthes albida, *Baker, Bot. Mag.* t. 7110.
Distrib. Perak, Penang, and Borneo.

Smilax aspericaulis, *Wall. Cat.* n. 5129.
Distrib. Perak and Selangor, India and Andamans.

Dracæna elliptica, *Thunb. Diss. Bot. Drac.* 6.
Distrib. Common in the Malay Peninsula; Silhet, Burmah, Andamans, and Malay Islands.

COMMELINACEÆ.

Forrestia glabrata, *Hook. in Flora,* xlvii. (1864) 360.
Distrib. India, Tonkin, Java, and Sumatra.
A new addition to our flora.

PALMÆ.

Pinanga polymorpha, *Becc. Malesia,* iii. 173.
Distrib. Perak, Selangor.

Pinanga Scortechinii, *Becc. Malesia,* i. 170.
The petals of the male flowers are in this form lanceolate and acute, not ovate.
Distrib. Penang, Perak, Selangor.

Iguanura geonomæformis, var. malaccensis, *Ridl. Mat. Fl. Mal.* ii. 150.
The form with the leaves cut into many lobes.
Distrib. Malay Peninsula.

Calamus viridispinus, *Becc. in Hook. f. Fl. Brit. Ind.* vi. 458.
Distrib. Perak.

ARACEÆ.

Arisæma anomalum, *Hemsl. in Journ. Bot.* xxv. (1887) 205.
Distrib. Perak.

AMORPHOPHALLUS BUFO, *Ridl. in Journ. Fed. Mal. States Mus.* iv. (1909) p. 89.
Distrib. Perak at Telom.

AGLAONEMA SCHOTTIANUM, *Miq. Fl. Ind. Bat.* iii. 316.
Distrib. Burmah, Malay Peninsula, Borneo.

PIPTOSPATHA ELONGATA, *Ridl. Mat. Fl. Mal. Pen.* iii. 35.
Distrib. Hills of the Malay Peninsula and Borneo.

ANADENDRUM MONTANUM, *Schott, in Bonplandia*, v. (1857) 451; *Prod.* 391.
Distrib. Whole Peninsula, Tenasserim, Borneo.

CYPERACEÆ.

SCLERIA RADULA, *Hance, in Ann. Sc. Nat.* sér. 4, xviii. (1862) 232.
Distrib. Perak, Hongkong.

GAHNIA JAVANICA, *Mor. Verz. Zoll. Pfl.* 98.
Distrib. High altitudes, Malay Peninsula.

GRAMINEÆ.

PANICUM PATENS, *Linn. Sp. Pl.* 86.
Distrib. Indo-Malaya, Polynesia.

PANICUM PILIPES, *Nees & Arn.*; *Miq. Pl. Jungh.* iii. 376.
Distrib. Common in the East from the Mascarene Isles to Polynesia.

PANICUM SARMENTOSUM, *Roxb. Fl. Ind.* i. 308.
Distrib. Indo-Malaya, China.

PANICUM UNCINATUM, *Raddi, Agrost. Bras.* 41.
Only previously met with at Temengoh.
Distrib. India, Ceylon, Malay Islands, and South America.

THYSANOLÆNA AGROSTIS, *Nees, in Edinb. Phil. Journ.* xviii. (1835) 180.
Distrib. Penang, Perak, Selangor.

LOPHATHERUM GRACILE, *Brongn. in Duperr. Voy., Bot.* 50, t. 8.
Distrib. Tropical and Warm Asia.

FILICES.

ALSOPHILA COMMUTATA, *Mett. in Ann. Mus. Lugd.-Bat.* i. 53.
Distrib. Hills of the Malay Peninsula.

ALSOPHILA LATEBROSA, *Hook. Sp. Fil.* i. 37.
Distrib. Common all over the Malay Peninsula.

HYMENOPHYLLUM JAVANICUM, *Spreng. Syst.* iv. 132.
Distrib. Mascarene Isles, India, Malaya, Australia.

TRICHOMANES PALLIDUM, *Blume, Enum. Pl. Jav.* 225.
Distrib. Common on all the hills of the Peninsula ; Java.

TRICHOMANES RIGIDUM, *Sw. Prodr.* 137.
Distrib. Most of the Tropics.

TRICHOMANES PLUMA, *Hook. Ic. Pl.* t. 997.
Distrib. Common on the hills at 4000 feet alt. ; Malaya Islands.

TRICHOMANES MAXIMUM, *Blume, Enum. Pl. Jav.* 228.
Distrib. Malay Peninsula and Islands and Polynesia.

TRICHOMANES AURICULATUM, *Blume, Enum. Pl. Jav.* 225.
Distrib. Selangor and Perak, Malay Isles, Japan, and Guiana.

LEUCOSTEGIA NODOSA, *Bedd. Ferns Brit. Ind. Suppl.* 4.
Only hitherto recorded from Gunong Buba in Perak.
Distrib. India and Java.

DAVALLIA DIVARICATA, *Blume, Enum. Pl. Jav.* 237.
Distrib. Rare. Perak, also Java.

LINDSAYA FLABELLULATA, *Dryand. in Trans. Linn. Soc.* iii. (1797) 41, t. 8. f. 2.
Distrib. Tropical Asia and Australia.

LITOBROCHIA INCISA, *Presl, Tent.* 149.
Distrib. Tropics generally.

BLECHNUM ORIENTALE, *Linn. Sp. Pl.* ed. 1, 1077.
Distrib. Eastern Tropics.

ASPLENIUM HIRTUM, *Kaulf. Enum. Fil.* 169.
A large form with long acuminate pinnæ.
Distrib. Malaya, Madagascar, Mascarene Islands, Seychelles, Polynesia.

A. NITIDUM, *Sw. Syn. Fil.* 280.
Distrib. S. Africa to Indo-Malaya.

A. TENERUM, *Forst. f. Prod.* 80.
Distrib. Ceylon, Malaya, and Polynesia.

ASPLENIUM AMBOINENSE *Willd. Sp. Pl.* v. 303.
Distrib. Mergui, Tavoy, Polynesia.

DIPLAZIUM BANTAMENSE, *Blume, Enum. Pl. Jav.* 191.
Distrib. Indo-Malaya, China.

DIPLAZIUM TOMENTOSUM, *Blume, Enum. Pl. Jav.* 192.
Distrib. Common. Burmah, Malaya.

DIDYMOCHLÆNA LUNULATA, *Desv. in Mém. Soc. Linn. Paris,* ii. (1827) 282.
Distrib. Malay Peninsula, Burmah, Mascarene Islands, Polynesia, America.

MESOCHLÆNA POLYCARPA, *Bedd. Ferns Brit. Ind. Suppl.* 13.
Distrib. Malay Peninsula and Islands.

ASPIDIUM PACHYPHYLLUM, *Kunze, in Bot. Zeit.* 1848, 259.
Distrib. Malay Peninsula and Islands.

LASTREA IMMERSA, *T. Moore, Index Fil.* p. lxxxix.
Distrib. Malay Peninsula and Islands.

LASTRÆA CALCARATA *T. Moore, Index Fil.* 87.
Distrib. India and Malaya.

LASTRÆA SPARSA, *T. Moore, Index Fil.* 104.
A new record for the Malay Peninsula.
Distrib. India, Ceylon, Malay Isles, China, Mauritius.

NEPHRODIUM HETEROCARPUM, *T. Moore, Index Fil.* 93.
Distrib. Malaya.

NEPHROLEPIS DAVALLIOIDES, *Kunze, in Bot. Zeit.* 1846, 460.
Distrib. Malay Peninsula, Java.

OLEANDRA NERIIFORMIS *Cav., in Anal. Hist. Nat. Madrid,* i. (1799) 115.
Distrib. Common on our hills above 3000 feet.

POLYPODIUM HIRTELLUM, *Blume, Enum. Pl. Jav.* 123.
Distrib. Hills at 4000 feet, also Ceylon.

GYMNOGRAMMA CALOMELANOS, *Kaulf. Enum. Fil.* 76.
Distrib. Tropics, Natal.

ELAPHOGLOSSUM LAURIFOLIUM *T. Moore, Index Fil.* p. xvi.
Distrib. Tropical Asia, Mascarene Islands.

ANGIOPTERIS EVECTA *Hoffm. Comm. Soc. Reg. Gott.* xii. 29, t. 5.
Distrib. Madagascar, Indo-Malaya, Japan, Polynesia.

LYCOPODIACEÆ.

SELAGINELLA WALLICHII, *Spring, Mon.* ii. 143.
Common in the hill districts.
Distrib. Indo-Malaya.

MUSCI.

POGONATUM MACROPHYLLUM, *Dozy & Molkenb. Bry. Jav.* i. 45, t. 35.
Distrib. Malay Archipelago.

RHIZOGONIUM SPINIFORME, *Bruch, in Flora*, xxix. (1846) 134.
Distrib. Throughout the tropics.
Both these mosses are common in the Malay Peninsula.

REPORTS on the MARINE BIOLOGY of the SUDANESE RED SEA.—IX. ALGÆ (Supplement).

By R. J. HARVEY-GIBSON, M.A., F.L.S., Professor of Botany, and MARGERY KNIGHT, B.Sc., Assistant-Lecturer in Botany, University of Liverpool.

(With 4 Text-figures.)

[Read 20th February, 1913.]

IN Vol. xxxi. of the Society's Journal (Zoology), pp. 76–80 (1908), and reprinted in Vol. xxxviii. (1909), Botany, pp. 441–445, a brief account was given by one of us (R. J. H.-G.) of a small collection of Marine Algæ made by Mr. C. Crossland in the years 1904 and 1905, while making investigations on the Marine Fauna of the Sudanese Coast. That collection included 35 species equally divided between Chlorophyceæ, Phæophyceæ, and Rhodophyceæ. In 1910, Mr. Crossland forwarded another small collection of Marine Algæ from the same region (chiefly from Khor Dongolab), but pressure of other work has prevented any detailed examination of the material until the present year (1912). This second collection includes 48 species (apart from varieties and forms), 36 of which are additions to the previous list. Four of these 36 are Cyanophyceæ, 10 are Chlorophyceæ, 8 are Phæophyceæ, and 14 are Rhodophyceæ.

The chief memoirs consulted have already been recorded in the paper above mentioned, and need not be repeated here; but we have had occasion to refer also to two important monographs by Mr. A. Gepp and Mrs. E. S. Gepp, viz.:—"Marine Algæ (Chlorophyceæ and Phæophyceæ)," and "Marine Phanerogams of the 'Sealark' Expedition," Trans. Linn. Soc. ser. 2 (Bot.) vol. vii. pt. 10; and "The Codiaceæ of the Siboga Expedition," Mono. lxii.

We have also to express our thanks to Mr. Gepp for kindly identifying one of the Phæophyceæ which we had difficulty in determining.

(Species not present in the previous collection are indicated by an asterisk.)

CYANOPHYCEÆ.

*1. SPHÆROZYGA CARMICHAELI, *Harv.*

*2. LYNGBYA SEMIPLENA (*Ag.*), *J. Ag.*

*3. CALOTHRIX PARASITICA (*Chauv.*), *Thur.*

*4. DERMOCARPA PRASINA (*Reinsch*), *Born.*

CHLOROPHYCEÆ.

*5. Halimeda Tuna, *Lamour.*, f. typica, *Bart.*
*6. Halimeda Opuntia, *Lamour.*, f. typica, *Bart.*
" " " f. triloba, *Bart.*
* " " " f. cordata, *Bart.*
7. Codium tomentosum, *Kütz.*
*8. Codium tenue, *Kütz.*
9. Avrainvillea lacerata, *J. Ag.*, f. typica, *Bart.*
" " " f. robustior, *Bart.*
*10. Caulerpa Freycinetii, *J. Ag.*, var. de Boryana, *Van Bosse.*
*11. Caulerpa cupressoides, *J. Ag.*, var. Lycopodium, *Van Bosse.*
*12. Caulerpa scalpelliformis, *R. Br.*
13. Caulerpa racemosa, *J. Ag.*, var. uvifera, *J. Ag.*
14. Udotea argentea, *Zan.*, f. typica, *Bart.*
*15. Flabellaria minima, *Gepp.*
*16. Bryopsis implexa, *De Not.*
" " " var. elegans, *Hauck.*
*17. Chætomorpha Linum, *Kütz.*
*18. Valonia ægagropila, *J. Ag.*
19. Dictyosphæria favulosa, *Decne* ?.

PHÆOPHYCEÆ.

20. Sargassum subrepandum, *J. Ag.*
21. Sargassum dentifolium, *J. Ag.*
*22. Sargassum linifolium, *J. Ag.*
*23. Crystoseira amentacea, *Bory.*
*24. Turbinaria decurrens, *Bory.*
*25. Zanardinia collaris, *Crouan.*
26. Padina pavonia, *J. Ag.*
*27. Zonaria variegata, *Mart.*
28. Hydroclathrus cancellatus, *Bory.*
*29. Hydroclathrus sinuosus, *Zan.*
*30. Dictyota dichotoma, *J. Ag.*, var. implexa, *Hauck.*
*31. Sphacelaria cirrhosa, *J. Ag.*, var. minima, *Zan.*

RHODOPHYCEÆ.

32. SPYRIDIA FILAMENTOSA, *J. Ag.* (With cystocarpia and antheridia.)

*33. GELIDIUM CRINALE, *Thur.*

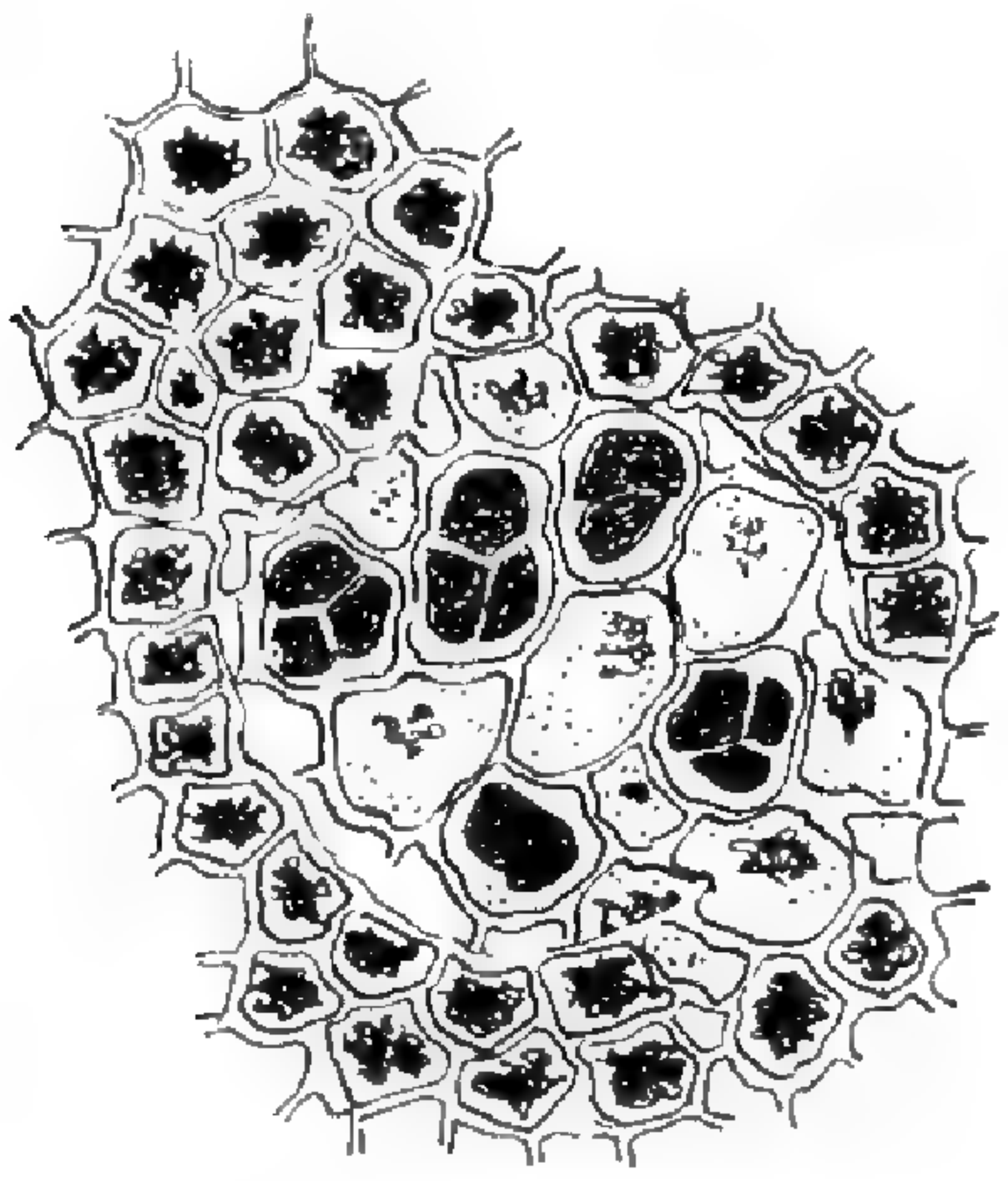
*34. LIAGORA VISCIDA, *Ag.* (With cystocarpia and antheridia.)

*35. DIGENEA SIMPLEX, *Ag.*

*36. GALAXAURA ADRIATICA, *Zan.*

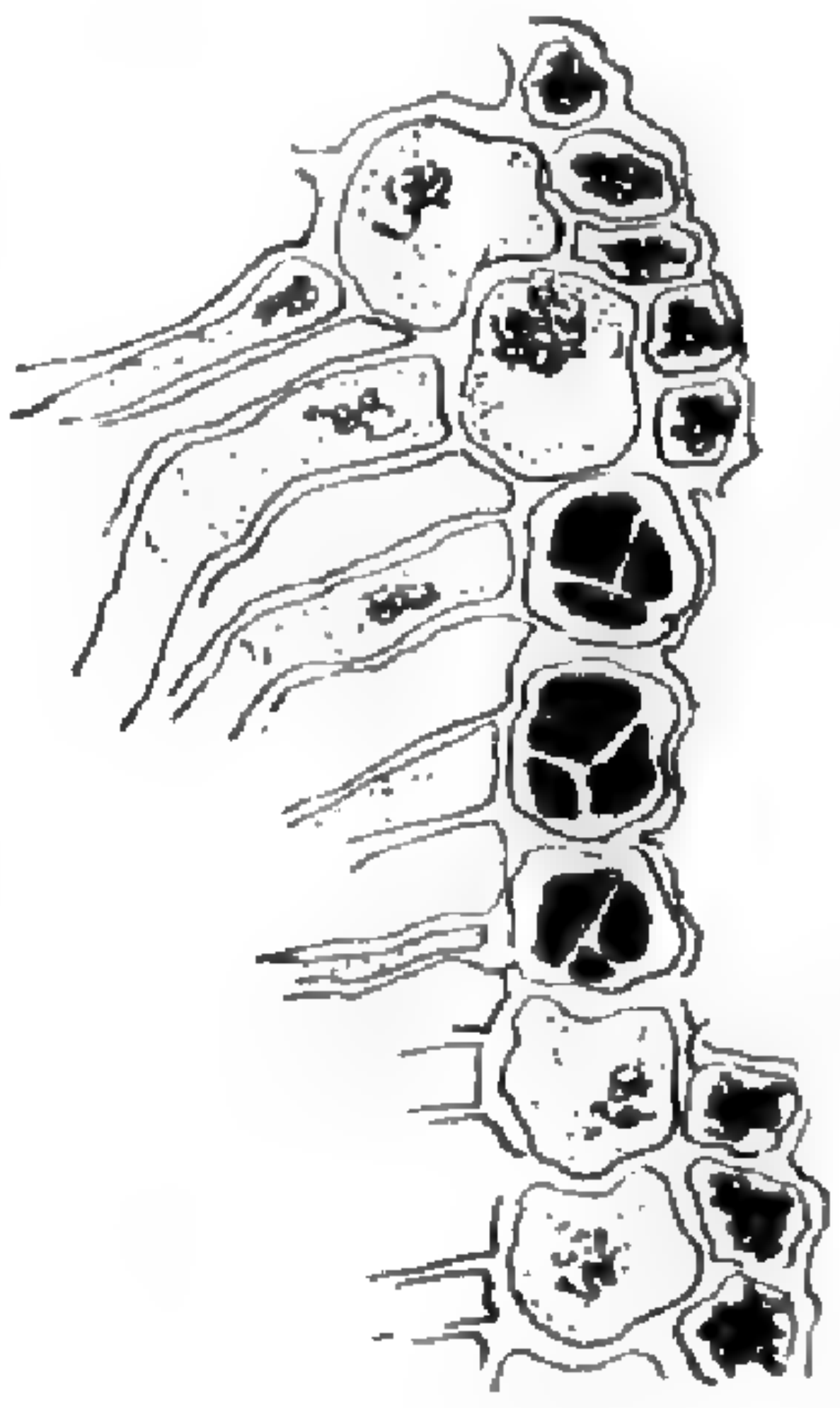
Hauck ('Die Meeresalgen Deutschlands und Œsterreichs') states that antheridia and tetragonidangia (tetrasporangia) are unknown in the genus. Only one plant of this species was present in the collection, but it was of special interest inasmuch that it bore both cystocarpia and tetragonidia. The gonidangia are developed on the terminal branches, and on surface view appear at the base of shallow depressions in the thallus. The main body of the thallus consists of loosely woven hyphæ passing over into shorter cells lying at right-angles to the surface. The exterior ends of these cells abut on a subepidermal layer of large cells, covered in turn by a compact external layer of rather smaller cells, which present a mosaic on surface view. The superficial cells are strongly calcified. The tetragonidia are formed in the subepidermal layer, and the mother-cell contents divide in the tetrahedral manner into the four tetragonidia. As the gonidangia mature the superficial cell-layer disappears, forming the shallow depression seen on surface view (figs. 1, 2). Cystocarpia are formed in the same branch and at the bottom of similar depressions.

Fig. 1.



Surface view of the tetragonidial region. × 450.

Fig. 2.



Tetragonidial region in section. × 450.

While investigating the Marine Algæ of the Isle of Man, we have been struck with the frequency with which we have met with sexual and asexual organs, not merely on the same plant but on the same branch. This phenomenon we have observed in *Lophothalia byssoides*, *Callithamnion Hookeri*, *Callithamnion tetragonum*, *Callithamnion corymbosum*, and

Polysiphonia violacea. Indeed, we have been forced to the opinion that the joint occurrence of sexual and asexual cells on the same plant is by no means an exceptional phenomenon, and Mr. A. D. Cotton informs us that he has noticed the same joint occurrence in *Laurencia hybrida* and *Callithamnion* sp. In his paper on *Polysiphonia violacea* (Bot. Gaz. vol. xlii. 1906, p. 401), Yamanouchi demonstrates, in that species, a regular alternation of generation between a gametophyte with 20 chromosomes and a sporophyte with 40 chromosomes. At the same time, he records under the head of "Abnormalities," the occurrence of tetragonidia on cystocarpic or antheridial plants, and refers to similar cases noted by Lotsy in *Chylocladia kaliformis*, and by Davis in *Spermothamnion Turneri* and *Callithamnion Baileyi*. He adds, "Such cases should be carefully investigated to determine whether true tetraspores are present or whether the structures are not really of the nature of monospores, as in *Polysiphonia*, and developed with a suppression of reduction phenomena." In the plants of *Polysiphonia violacea* collected by us in 1912 at Port Erin, Isle of Man, cystocarpia and gonidangia were frequently present on the same branch, and the number of cases we met with, both in that species and in other genera, in our opinion, scarcely justifies the view that all of these are to be regarded as abnormalities. One of us is at present engaged on a detailed investigation of the matter from the cytological point of view, the results of which it is hoped to publish shortly. (See note, p. 309.)

37. LOMENTARIA SQUARROSA, *Kütz.*

38. HYPNÆA VALENTIÆ, *J. Ag.* (With cystocarpia and tetragonidia.)

In this plant also we found both sexual and asexual reproductive organs in the same individual, indeed all the specimens were covered with "fruit" of both types. The cystocarpia are of the normal *Hypnæa* type. The tetragonidangia divide in a zonate manner and are formed abundantly from the superficial cells of ovoid pointed stichidia (fig. 3). The specimens were also interesting as exhibiting "Brutknospen," or vegetative buds, closely resembling those of *Sphacelaria*. The adult form of these buds is stellate (fig. 4 *a*, *b*, *c*, *d*), but all stages in their development could be readily traced on the same plant.

*39. LAURENCIA OBTUSA, *Lamour.* (With cystocarpia and antheridia.)

*40. DUDRESNAYA COCCINEA, *Crouan.* (With cystocarpia and antheridia.)

*41. POLYSIPHONIA UTRICULARIS, *Zan.*

42. LAURENCIA PAPILLOSA, *Grev.* (With cystocarpia.)

*43. MELOBESIA THURETII, *Born.* (On *Jania rubens*, with cystocarpia.)

*44. LITHOTHAMNION POLYMORPHUM, *Aresch.*

*45. LITHOTHAMNIUM FASCICULATUM, *Aresch.*

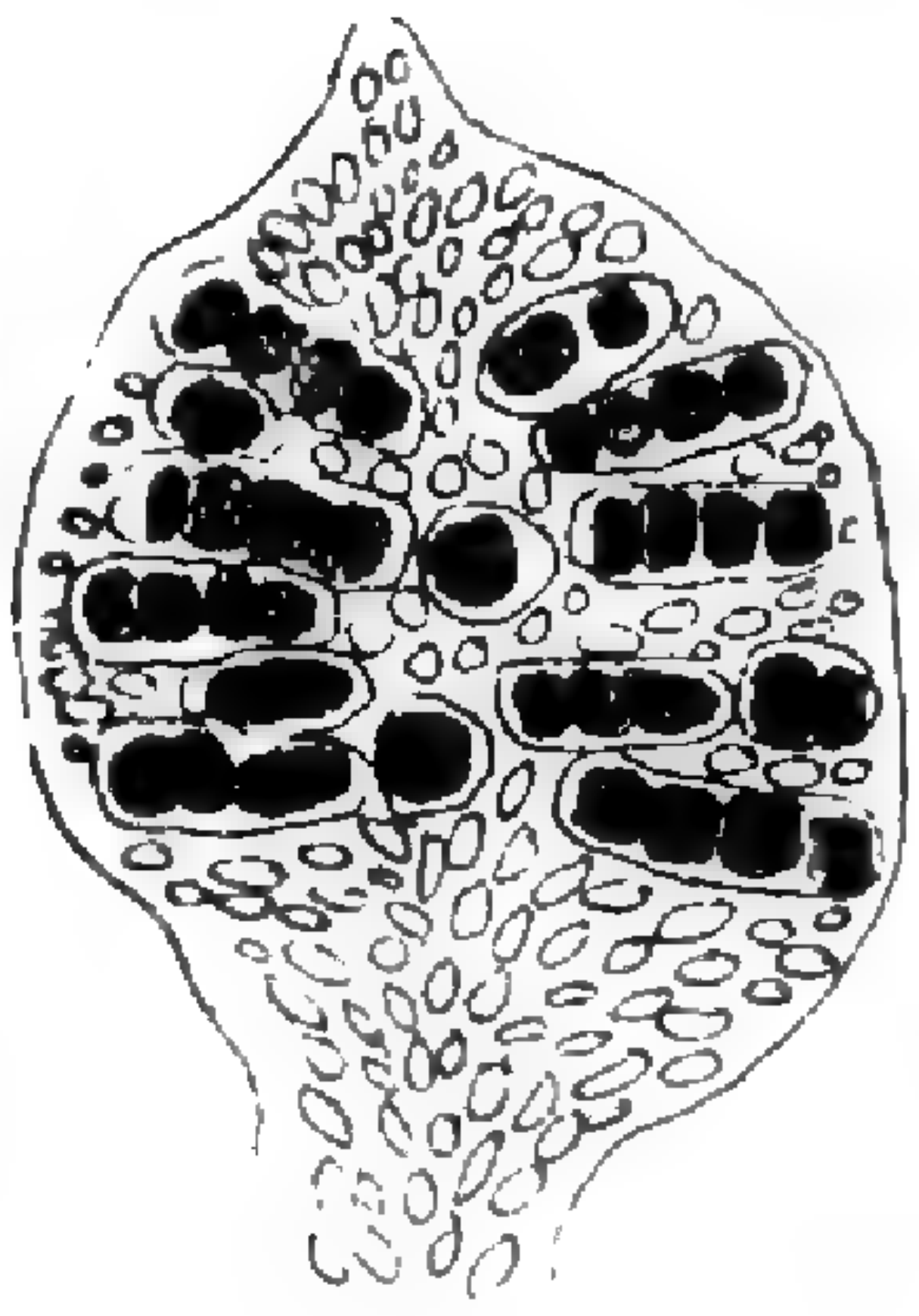
*46. Lithophyllum expansum, *Phil.*

*47. Lithophyllum crispatum, *Hauck.*

*48. Jania rubens, *Lamour.*

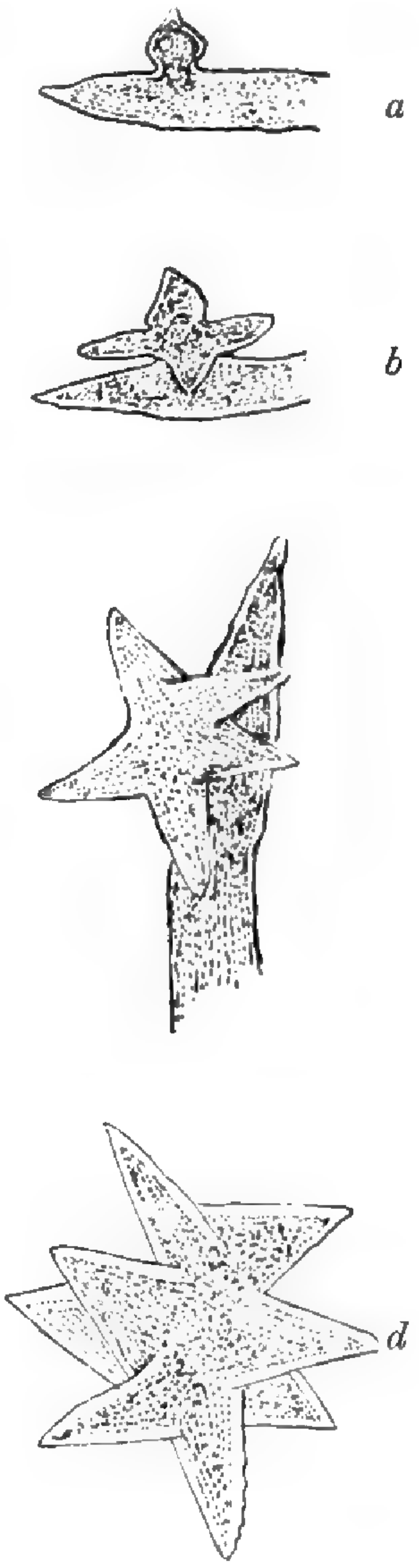
The collection also included fragments of Marine Phanerogams, more especially *Salicornia fruticosa,* Linn., *Cymodocea nodosa,* Asch., and *Halophila stipulacea,* Asch.

Fig. 3.



Longitudinal section of stichidium of *Hypnæa Valentiæ.*

Fig. 4.



Stages in the development of a vegetative bud of *Hypnæa Valentiæ.*

[Since writing the above paper we have noticed an article in the Bot. Gazette, Aug. 1912, by G. B. Rigg and A. D. Dalgity, in which similar phenomena are discussed in connection with another species of Polysiphonia, viz., *Pterosiphonia bipinnata.* The authors indicate their intention of continuing the study of this plant from a cytological point of view. We still intend, however, to continue the research indicated above, as it may be of interest to compare the cytological conditions underlying this phenomenon in plants gathered from both western and eastern shores of the Atlantic.—R. J. H.-G. & M. K., 7th January, 1913.]

On the Genera *Radamæa*, Bentham, and *Nesogenes*, A. de Candolle.

By W. Botting Hemsley, F.R.S., F.L.S., V.M.H.

[Read 20th February, 1913.]

(Plate **14.**)

By permission of the Director of the Royal Botanic Gardens, Kew, I am able to give the Society some interesting facts in phytogeography as exemplified by the genus *Nesogenes* in Coral Island Floras.

In the year 1846 Bentham founded and described the genus *Radamæa* (DC. Prodr. x. 509) on a Madagascar shrub, to which he gave the specific name of *montana*. He also referred imperfect specimens of a plant from the Agalega (Galega) Islands to this genus which he named *Radamæa prostrata*. I may mention in passing that the derivation of *Radamæa* is not given, but it doubtless commemorates King Radama I. of Madagascar, who abolished export slave-trade and favoured christian missionaries. *Radamæa montana* is now well known, and it is figured in Hooker's 'Icones Plantarum,' t. 1406. It is a shrub from 5 to 10 feet high and a characteristic Scrophulariacea, having small, opposite leaves and salver-shaped corollas. *Radamæa prostrata*, as I shall presently show, is not of the same genus nor of the same family.

Among the plants collected in the Coral Islands on Beechey's Voyage to the Pacific and Behring Strait, 1825 to 1828, was a herb with the aspect of some Scrophulariaceæ or Labiatæ. This was described by Hooker and Arnott in the Botany of the Voyage, 67, under the name of *Myoporum? euphrasioides*. Subsequently, in 1847, A. de Candolle, Prodromus, xi. 703, raised it to generic rank, calling it *Nesogenes*, "nomen ex origine insulari"; still retaining it in the Myoporaceæ. He gives the habitat as: "In insula Whitsunday, id est Pentecôtes, non procul a Nova Caledonia." This is an error, and is corrected below in the general distribution of *Nesogenes euphrasioides*.

The botanical collectors of Wilkes's United States Exploring Expedition, 1838 to 1842, obtained specimens of *Nesogenes euphrasioides*, and Asa Gray published a much fuller description of it in the 'Proceedings of the American Academy of Sciences,' vi. (1862) 51, than had previously appeared and referred it to the Verbenaceæ, to which it undoubtedly belongs. Such is the early history of this interesting genus. The finding, by Dr. Bayley Balfour, of a second species in the Mascarene Island, Rodriguez, on the Transit of Venus Expedition, 1874, was a geographical surprise. As a species, *N. decumbens*, Balf. fil., Transactions of the Royal Society, clxviii. reprint p. 61, t. 31, is quite distinct from the Pacific Islands *N. euphrasioides*.

Apparently it is very rare, having been found "only in one place, on a patch of coralline limestone, about three-quarters of a mile from the sea, at the west end of the island, close to where *Hypoestes inconspicua*, Balf. fil., and *Dichondra repens*, Forst., were found."

The next phase in the history of *Nesogenes* is the discovery of the existence of other species in the region of *N. decumbens*. As circumstances have permitted since my retirement from Kew in 1908, I have studied the botanical collections of the 'Sealark' Expedition made by Prof. J. Stanley Gardiner and Mr. J. C. F. Fryer, in Seychelles and Aldabra, in 1905, and those made in the same islands by the Hon. H. P. Thomasset, of Mahé, Seychelles, and Mr. P. R. Dupont, Curator of the Botanic Station in the same island. Among these plants is one, or possibly two, species of *Nesogenes* from Aldabra and Assumption, coral islands situated some 200 miles to the north-west of Madagascar, in about 10° S. lat. Judging by appearance only, I at first sorted the specimens into the Labiatæ, but on examining the flowers I found they belonged to the Verbenaceæ. When naming the Scrophulariaceæ I looked cursorily at *Radamæa*, and these specimens of *Nesogenes* recalled to my mind similarity in habit. On comparison I discovered that *Radamæa prostrata* is indeed a species of *Nesogenes*. In view of the fact that endemic plants are exceedingly rare in atolls, the affinities and distribution of the species of *Nesogenes* are points of great interest. In this connection I may mention that the vegetation of Aldabra is by far richer than that of any other atoll with which I am acquainted and includes a considerable number of species hitherto apparently undescribed or unknown elsewhere. Nevertheless, judging from the composition of the vegetation of atolls generally, and considering that the flora of Madagascar is still far from having been exhaustively investigated, I strongly doubt the existence of a real endemic element in the vegetation of Aldabra. In making this comparison I exclude the flora of the Bermudas, because I do not think it belongs to the same category. But even of that flora the endemic element is very small and very slightly differentiated. The fact that the Laccadive, Maldive, and Chagos archipelagos of the Indian Ocean contain no endemic plants, if we exclude a doubtful fern, supports this view.

The genus *Nesogenes* presents no striking characteristics. It consists of small, slender, procumbent or erect herbs or undershrubs with opposite leaves, mostly less than an inch in length, and axillary, inconspicuous flowers less than half-an-inch long. In habit and general appearance the plants resemble some species of *Euphrasia* and *Buchnera* in Scrophulariaceæ rather than characteristic Verbenaceæ. The genus is placed in the tribe Chloantheæ by Bentham & Hooker, 'Genera Plantarum,' ii. 1141, between *Spartothamnus*, an Australian shrubby monotype, and *Acharitea* (probably derived from ἄχαρις, wanting in grace or beauty), a very slender herbaceous monotype from Madagascar. *Acharitea* differs from *Nesogenes* in the "calyx fructifer auctus et fructus pericarpium membranaceum." The description below of *N. Dupontii* practically embodies the diagnosis of the genus, and Plate **14**, together with the figure in Balfour's 'Botany of Rodriguez,' is sufficient pictorially to convey an idea of the kind of plants under consideration. There are four, or perhaps five, species now known.

1. NESOGENES EUPHRAXIODES, *A. DC.* Prodr. xi. (1847) 703. Drake del Castillo, Flore de la Polynésie Française, 151 (1893).

Nesogenes euphrasioides, A. Gray, in Proceedings of the American Academy of Sciences, vi. (1862) 51.

Myoporum ? euphrasioides, Hooker & Arnott, Botany of Beechey's Voyage, 67 (1832); Guillemin in Annales des Sciences Naturelles, 2^{me} série, Botanique. vii. (1837) 242.

Buchnera ? Chamisso in Kotzebue's Voyage of Discovery (1815–1818), English Translation, iii. 222.

Herba erecta, rigida, fere undique hispida, caulibus basi lignescentibus. Folia spathulata, apice rotundata, deorsum attenuata, vix unquam 2·5 cm. longa.

Paumotu, Low or Dangerous Archipelago, and Ducie Island, approximately between 120° and 150° west longitude, and between 15° and 20° south latitude: Whitsunday Island (Vahitai), Beechey; Bow Island (Hao), Hinds, 1841; Barclay; Chain Island (Anaä), Cuming n. 1400; Romanzoff Island (Tikei), Chamisso, 1830; Ducie Island, Cuming n. 1400; Coral Islands, Wilkes. These specimens are partly of the Hookerian Herbarium; partly of the Benthamian.

The geographical distribution of *Nesogenes euphrasioides* has been misunderstood and assumed to include three widely separated areas; partly in consequence of A. de Candolle having confused Pentecost Island of the New Hebrides with Whitsunday Island of the Low Archipelago; partly because Romanzoff Island has been mistaken for Romanzoff Islands in the Radak range of the distant Marshall Archipelago. Drake del Castillo, in the place cited above, records the plant from the Iles Pomoto, Lay and Collie, and King Island (Taiaro) Wilkes. The labelling of the Kew specimens of *Nesogenes euphrasioides* requires some further elucidation, as some bear the name of the collector, others the name of the donor. Captain F. W. Beechey was the Commander of H.M.S. 'Blossom' on a Voyage of Discovery in 1825 to 1828. G. T. Lay was Naturalist to the Expedition, and A. Collie was Surgeon, and their names are usually coupled as the collectors of the botanical specimens. R. B. Hinds was Surgeon on H.M.S. 'Sulphur,' commanded by Sir Edward Belcher on a Voyage around the

World, 1836 to 1842, and G. Barclay, a gardener, was plant collector on the same expedition. Hinds was editor of a part of Bentham's Botany of the "Sulphur," which does not include the Pacific Islands' collection (see Botany, p. 178), and I believe that the specimens of *Nesogenes euphrasioides* are here placed on record for the first time. As to Cuming's specimen labelled Ducie Island (Hooker's Herbarium) and bearing the same number as a reputed Chain Island specimen (Bentham's Herbarium), I suspect an error; other specimens in Cuming's collections having been proved to be incorrectly labelled. The islands in question are about 1200 miles apart.

2. NESOGENES PROSTRATA, *Hemsl.*

Radamæa prostrata, Benth. in DC. Prodr. x. 509; Baker, Flora of Mauritius and Seychelles, 242.

Centranthera prostrata, Bojer, Hort. Maurit. 246 (cult. in hort. Maurit.).

Centranthera thymoides, Bojer, in schedula in herb. Kew.

Herba vel fruticulus, undique hispidulus haud glandulosus, vix prostatus, 15–30 cm. altus, a basi dense ramosus, ramis gracilibus rigidis rectis subdistichis divergentibus. Internodia folia aequantia vel paullo longiora. Folia omnia parva, oblongo-lanceolata, 3–6 mm. longa, subobtusa, rigida, divaricata.

Agalega Islands, in about 56° 30′ E. and 10° 30′ S., Bojer.

There are several specimens in the Kew Herbarium from Bojer, Bouton and Blackburn; but none bearing good flowers, though sufficient to prove that the ovary is biovulate. These specimens were probably all collected by Bouton. Baker, in the place cited above, records this species from "Seychelles, Bojer," for which I find no evidence.

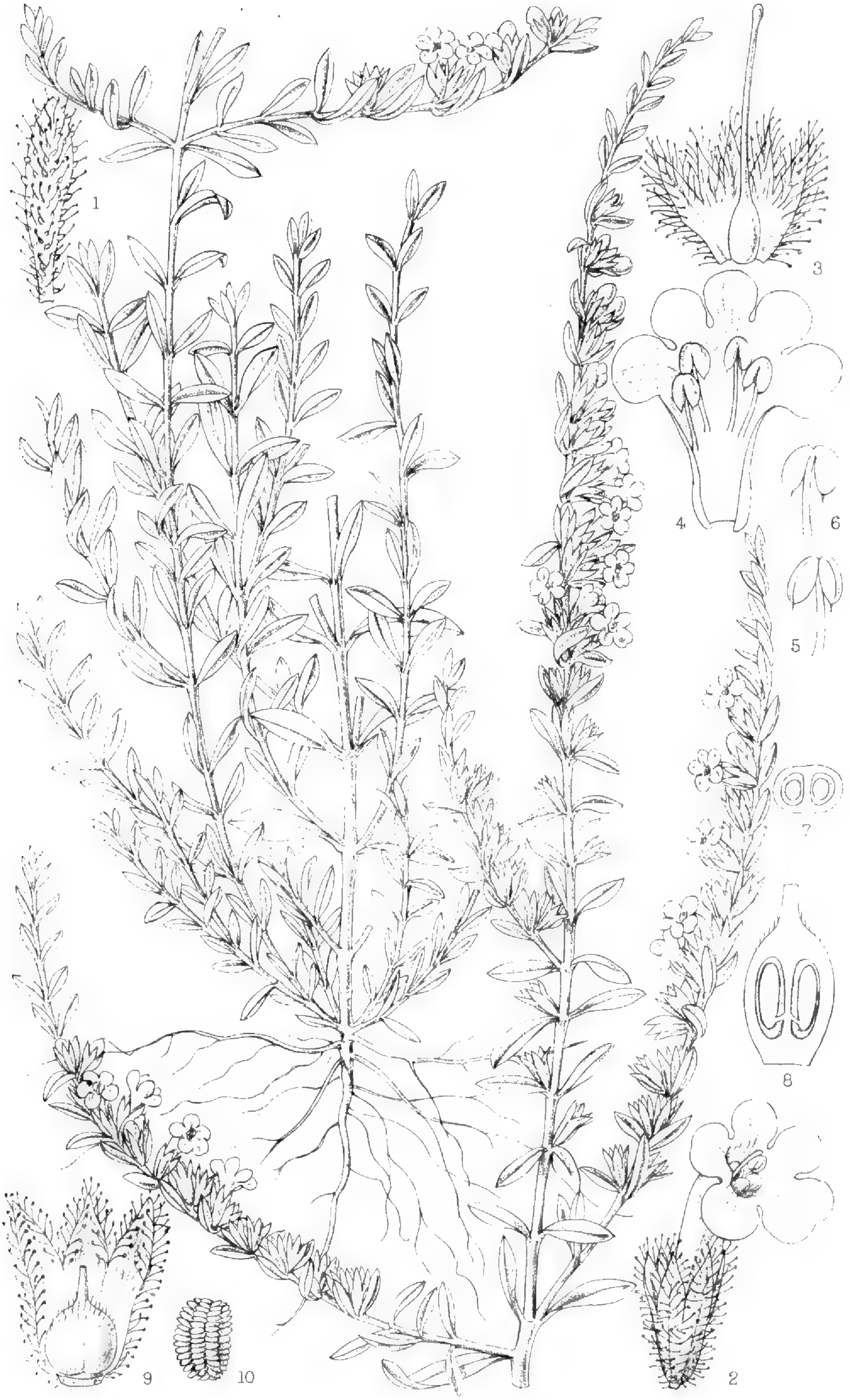
3. NESOGENES DECUMBENS, *Balf. fil.*, Botany of Rodriguez, 61, t. 31.

Herba diffusa, fere glabra, laxe ramosa, ramis tenuibus elongatis versus extremitatem biseriatim pilosis. Folia distincte petiolata, lanceolata, maxima vix 2·5 cm. longa, interdum obscure paucidenticulata, subtriplinervia, ciliata. Cymæ sæpe 2–4-floræ.

Rodriguez. In one locality only, I. B. Balfour.

4. NESOGENES DUPONTII, *Hemsl.*; species nova habitu *N. decumbenti* simillima sed differt imprimis fere undique piloso-hispidula et corollæ tubo angusto quam calyx plus quam dimidio longiore. (Pl. **14.**)

Herba procumbens vel decumbens, a basi ramosissima, ramis gracilibus flexilibus elongatis usque ad 45 cm. longis, fere undique pilis longis complanatis e basi lata longe acuminatis dense vestita, pilis nonnullis vel omnibus primum capitato-glandulosis, glandulis, ut videtur, cito deliquescentibus. Internodia quam folia sæpius paulo longiora. Folia radicalia non visa,



M. Smith del
J. N. Fitch lith.
West, Newman imp.

NESOGENES DUPONTII, *Hemsl.*

caulina opposita, distincte petiolata, crassiuscula, ovato-lanceolata vel oblonga, maxima visa cum petiolo circiter 2 cm. longa, sursum gradatim minora, vix acuta. Flores parvi, in axillis foliorum sæpissime solitarii, brevissime pedicellati. Calyx anguste campanulatus, 4–5 mm. longus, fructifer paulo auctus, rigidus, intus extusque dense glanduloso-pilosus, fere æqualiter 5-dentatus, 10-nervis; dentes acuti, quam tubus breviores, demum patentes. Corolla glabra, 1–1·3 cm. longa, subinfundibularis, ore leviter obliquo; tubus basi angustissimus, sursum paulo ampliatus; limbi lobi 5, breves, quorum 4 subæquales, fere orbiculares, quinto antico latiore. Stamina 4, subæqualia, inclusa vel e tubo brevissime exserta; filamenta filiformia, nuda; antheræ biloculares, basi affixæ, loculis ovatis fere a basi liberis inversis aristulatis. Ovarium oblongum, apice puberulum, 2-loculare, loculis 1-ovulatis; ovula erecta; stylus filiformis glaber, inclusus, stigmate parvo capitato. Fructus subcarnosus, calyce inclusus, dispermus; semina perfecta non visa.

Aldabra: P. R. Dupont, 97; H. P. Thomasset, 261.

Assumption: P. R. Dupont, 106.

Other specimens collected by Dupont were destroyed by insects.

NESOGENES species nova? habitu foliisque *N. prostrata* simillima sed florum structura vix a *N. Dupontii* differt.

Aldabra: H. P. Thomasset, 236.

The flowers of *N. prostrata* are still imperfectly known and the extent of variation in habit and foliage, due to local conditions, of any species is uncertain. The specimens of both this and *N. prostrata*, in spite of the name, have the appearance of erect growth; yet both have traces of adventitious roots on some of the branches. In the absence of complete material I decide not to give this a name.

From the geographical particulars given under the several species it will be seen that the genus *Nesogenes* is restricted to Coral Islands, or coral formation, in two very distant, relatively small areas within the southern tropic; the one in the Pacific Ocean with a median longitude of about 145° W.; the other in the Indian Ocean with a median longitude of about 60° E. This is all that is at present known of the distribution of the genus, but as the species are all very inconspicuous plants and much remains to be done in the botanical investigation of the region eastward from the Indian Ocean to the Low Archipelago, it is highly probable that intermediate stations may yet be discovered. On the other hand instances of genera, and even of species, occupying widely distant continental areas are not unknown, and the present conditions may be the result of disappearance from the intervening country due to physical changes. But it is not my intention to pursue the discussion of the question in this connection, and I will only repeat my belief that there is no real endemic element in the vascular vegetation of atolls. I am not sure whether the giant tortoises of the Seychelles and Galapagos offer a parallel in distribution.

I may add that the celebrated author and botanist, Adalbert de Chamisso, was apparently the first to collect the original species of *Nesogenes*, for I have no doubt that the plant he mentions in the Narrative of Kotzebue's Voyage, 1815 to 1818, as *Buchnera?* was the plant in question. The specimen in the Kew Herbarium recorded above confirms this supposition.

EXPLANATION OF PLATE 14.

Nesogenes Dupontii, Hemsl.

Fig. 1. Bracteole.
2. Flower.
3. Part of calyx laid open and pistil.
4. Corolla, opened showing attachment of stamens.
5. } Anthers
6. }
7. } Sections of the ovary.
8. }
9. Fruit, two sepals removed.
10. Seed.

All details enlarged.

The Anatomy of the Genus *Salicornia*.

By Ethel de Fraine, D.Sc., F.L.S. (University College, London).

(Plates **15** & **16**, & 14 Text-figures.)

[Read 6th April, 1911.]

[The present paper was intended to form the third of a series of papers on *Salicornia*, but various circumstances having prevented the other authors from completing their memoirs, it has been thought best not to delay the issue of this portion any longer.]

The anatomy of the Salicorniеæ * shows many features of interest correlated with the curious morphological configuration characteristic of the genus. The succulent, glabrous, shining internodes, which are so distinctive a feature in them, have been the subject of considerable discussion, and their morphology has been variously interpreted by different workers.

Babington †, Bentham ‡, and Hooker §, in their respective Floras, consider the genus to be made up of aphyllous plants, and that the green or reddish fleshy internodes represent merely the succulent stem cortex. On this theory, the whole assimilatory work of the plant is carried on by the stem.

A second opinion ‖ expresses the view that the small free tips of the succulent part of the stem segments represent the short, scaly leaves, which are arranged in decussate pairs.

A third theory, first put forward by Duval-Jouve ¶, regards the whole of the succulent "outer cortex" as foliar in origin. Our study of the anatomy of the various species of *Salicornia* has led us also to a similar conclusion.

The Leaf.

Duval-Jouve based his conclusion that the Salicornias have "des feuilles decurrentes, appliquées contre les entrenœuds, les recouvrant entièrement, soudées par leurs bords et ne s'isolant qu'a leur pointe contre la base de l'entrenœud supérieur, ce qui simule des articulations," chiefly upon the

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* A brief description of the specific characters of the species of Salicornieæ employed in this investigation has been published by Dr. Moss in the 'Journal of Botany,' vol. xlix. (June 1911), pp. 177–185.

† Babington, C. C.: Manual of British Botany, 9th ed. by H. & J. Groves, p. 350 (1904).

‡ Bentham, G.: Handbook of the British Flora, p. 436 (1858).

§ Hooker, Sir J. D.: Student's Flora of the British Isles, pp. 335 & 341 (1884).

‖ De Bary, H. A.: Comparative Anatomy of the Phanerogams and Ferns, Engl. Trans. Oxford, 1884, p. 297.

¶ Duval-Jouve, J.: in Bull. Soc. Bot. France, xv. (1868) p. 132.

evidence afforded by anatomical structure. Further, after some months of growth the succulent part of the segment falls off, so that the basal part of the branches of a perennial form shows a woody stem without any trace of the fleshy coating; a similar appearance is seen, towards the autumn, in the larger annual species also. This "falling off" of the fleshy sheath he considers lends further support to his view as to its foliar nature.

Dangeard *, in his researches on the structure of the Salicornieæ, also came to the conclusion that in them there existed a foliar sheath with palisade tissue. Further, he stated that in *Arthrocnemum fruticosum* Moq.† the sheath was distinct from the cortex throughout the internode. We have not, however, found this separation of sheath from internode in any of the species which we have examined. He attributes the formation of the sheath to the decurrence of the edges of the leaf down the stem; such a decurrence is a strongly marked feature in the alternate leaves of *Kalidium foliatum*, Moq., another member of the Salicornieæ. Monteil ‡, in his thesis on the comparative anatomy of the leaves of the Chenopodiaceæ, also adheres to the "foliar sheath" theory, and states that the Salicornieæ "ne sont pas aphylles comme le prétendent certains auteurs, mais les feuilles sont opposées, soudées par leurs bords et recouvrent chaque entre-nœuds, vers le haut duquel elles se séparent et s'isolent un peu en formant une saillie plus ou moins longue simulant une articulation." He bases his observations on the four species "*S. herbacea*, L.," "*S. fruticosa*, L.," "*S. patula*, D.-J.," and "*S. macrostachya*, Moric."

The considerations which have led us to believe that the succulent "cortex" of the Salicornias is foliar in origin, will be dealt with under six heads:—

1. The development of the shoot behind the apex.
2. The anatomy, and the course of the vascular bundles.
3. The structure of the flowering shoot.
4. The leaf-fall.
5. The morphology of the seedling.
6. The morphology of species of allied genera.

1. *The Development of the Shoot behind the Apex.*

The apical bud of a vegetative shoot of *Salicornia* consists of a meristematic mass of tissue closely covered with a number of decussately arranged leaves (text-fig. 3, **1**, p. 322). These leaves arise as small, pointed structures with a broad base of insertion, the leaf-bases of a pair of leaves nearly surrounding the stem at the node. Subsequently lateral fusion takes place between the adjacent margins of each pair of leaves, producing a connate leaf-base (text-fig. 3, 2), and meristematic activity in this region finally results in the production of a tubular leaf-sheath, which is crowned with the two free leaf-tips.

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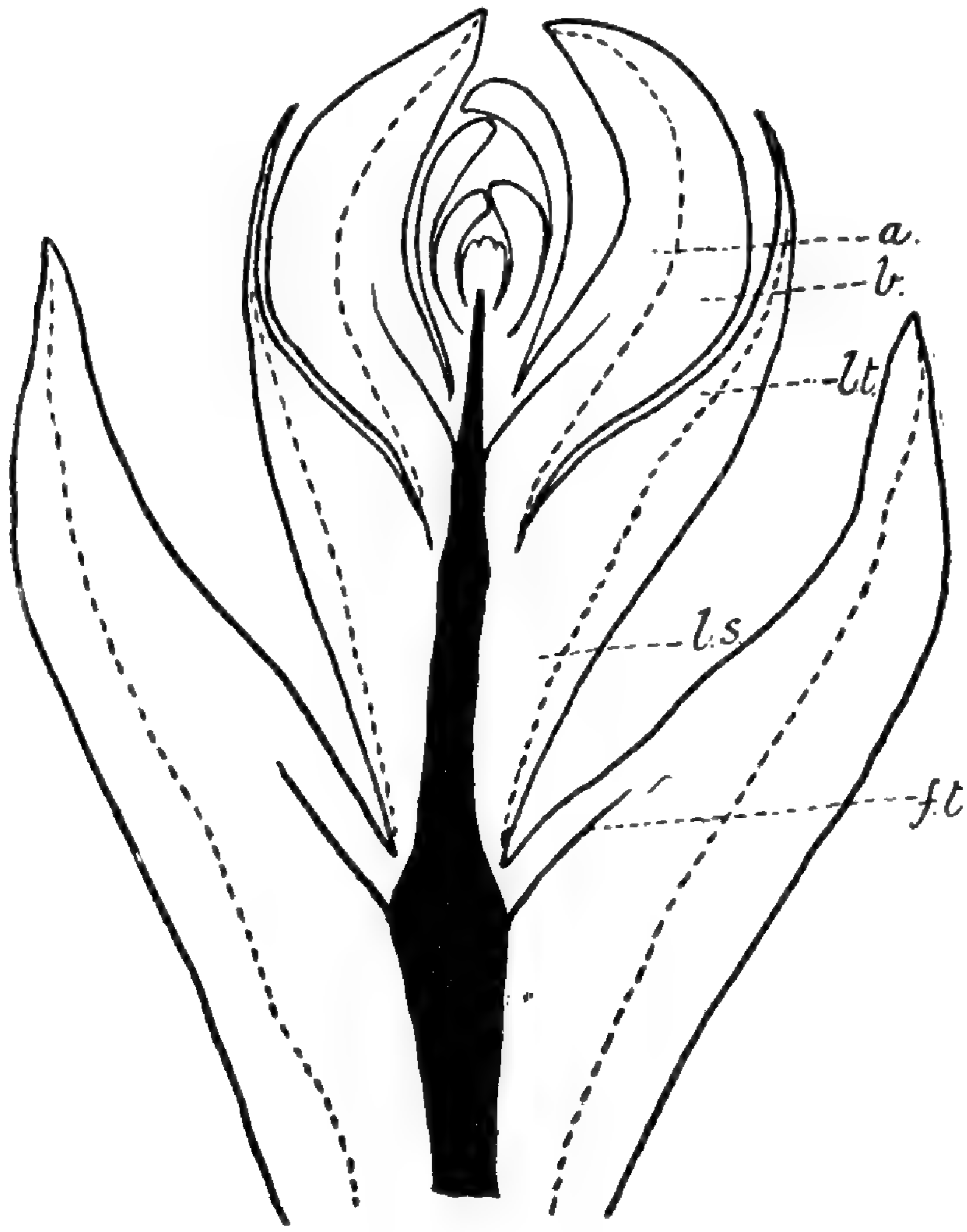
* Dangeard, P. A.: Bull. Soc. Linn. Normandie, sér. 4, ii. 1887, p. 93.

† This name includes *Salicornia glauca*, *S. fruticosa*, *S. radicans*, etc.

‡ Monteil, P.: "Anatomie comparée de la Feuille des Chenopodiacées." Thèse, Ecole supérieure de Pharmacie, No. 9, Paris, 1906, p. 124.

Fig. 1.*



Longitudinal section of the apex of a vegetative shoot of *S. fruticosa*, Linn., showing the development of the leaf-sheath with the elongation of the internodes. *a.* = aqueous tissue; *b.* = palisade parenchyma; *l.t.* = leaf-tip; *f.t.* = outgoing foliar trace; *l.s.* = leaf-sheath.

As the internodes of the stem elongate, the connate bases of the pairs of leaves elongate also, so that each internode is clothed with the basally developed leaf-sheath of the pair of leaves of the node immediately above. There is, of course, congenital union between the tissues of the stem and of the leaf-sheath, but it is always quite easy to trace the limiting layer †

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* Figs. 1, 2, 5 and 12 are drawn to scale by the aid of the camera lucida.

† As will be shown later in the paper, the "limiting layer" is the endodermis, which can be readily traced from node to node.

between the two (in transverse section), throughout the internode, until the nodal region of the next segment is reached.

2. *The Anatomy, and the Course of the Vascular Bundles.*

The structure of the free part of a leaf segment is, in its essential features, similar to that of any other succulent dicotyledonous leaf.

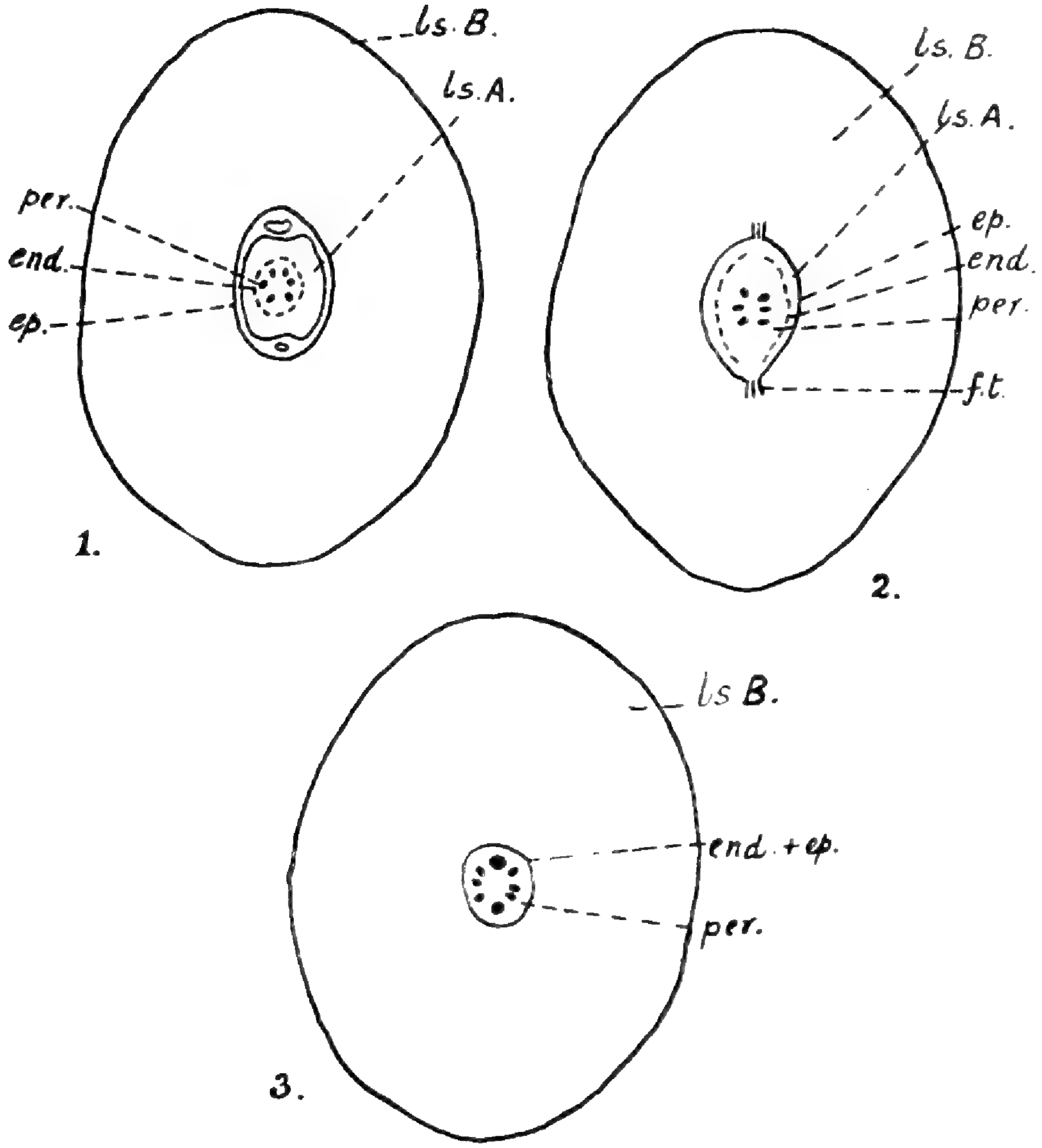
Since the connate leaf-bases and their two free segment-tips form a kind of socket into which the internode above seems to fit, the dorsal side of the leaf necessarily develops an assimilating area, usually consisting of two or three layers of palisade parenchyma. The rest of the leaf is made up of large parenchymatous cells devoid of chloroplasts, the intercellular spaces are very small, and the tissue evidently has its function in water storage. In the reddish forms this aqueous layer is filled with red cell-sap. A single-layered epidermis covers the palisade tissue; in it the stomata, which vary slightly in size and shape in the different species, are abundantly scattered, they show no peculiarity of structure and occur flush with the surface.

The development of the cuticle is usually very slight, except in *S. glauca* and *S. fruticosa*, and is in marked contrast with *Halocnemum strobilaceum*, which plant is well protected by a great thickness of cuticle. Between the palisade layer and the aqueous tissue run the numerous vascular bundles which constitute the network of the veins found in the free segment-tips, and the "cortical" series of bundles of the segment in its fused region.

The structure which has been described is characteristic not only of the free segment-tips and of the tubular leaf-sheath, but also of the internodal foliar sheath throughout the greater part of its length. Towards the base of the internode, however, the cells of the palisade layer of the sheath begin to diminish in length and finally disappear, the cells of the aqueous tissue shrink, and ultimately the sheath is reduced to a zone five or six rows deep composed of small parenchymatous elements (Pl. **15**. fig. 1). The stem in this region consists of a ring of vascular bundles, surrounded by two or three layers of pericyclic cells, and the endodermis abutting on to the much reduced foliar sheath; no true stem cortex exists (text-fig. 2, **1**); the endodermis however persists. The free leaf-sheath (*ls.B*) surrounding the node fuses with the structure as above described, but by the time the nodal region is passed the zone of small celled tissue, representing the foliar sheath of the internode above (*ls.A*), has entirely disappeared and the endodermis now abuts on to the new foliar sheath; the endodermis is the "limiting layer" so evident throughout the internodes (text-fig. 2, **2** & **3**).

The structure of the foliar sheath is, in its essential features, similar in all the Salicornieæ examined.

Fig. 2.



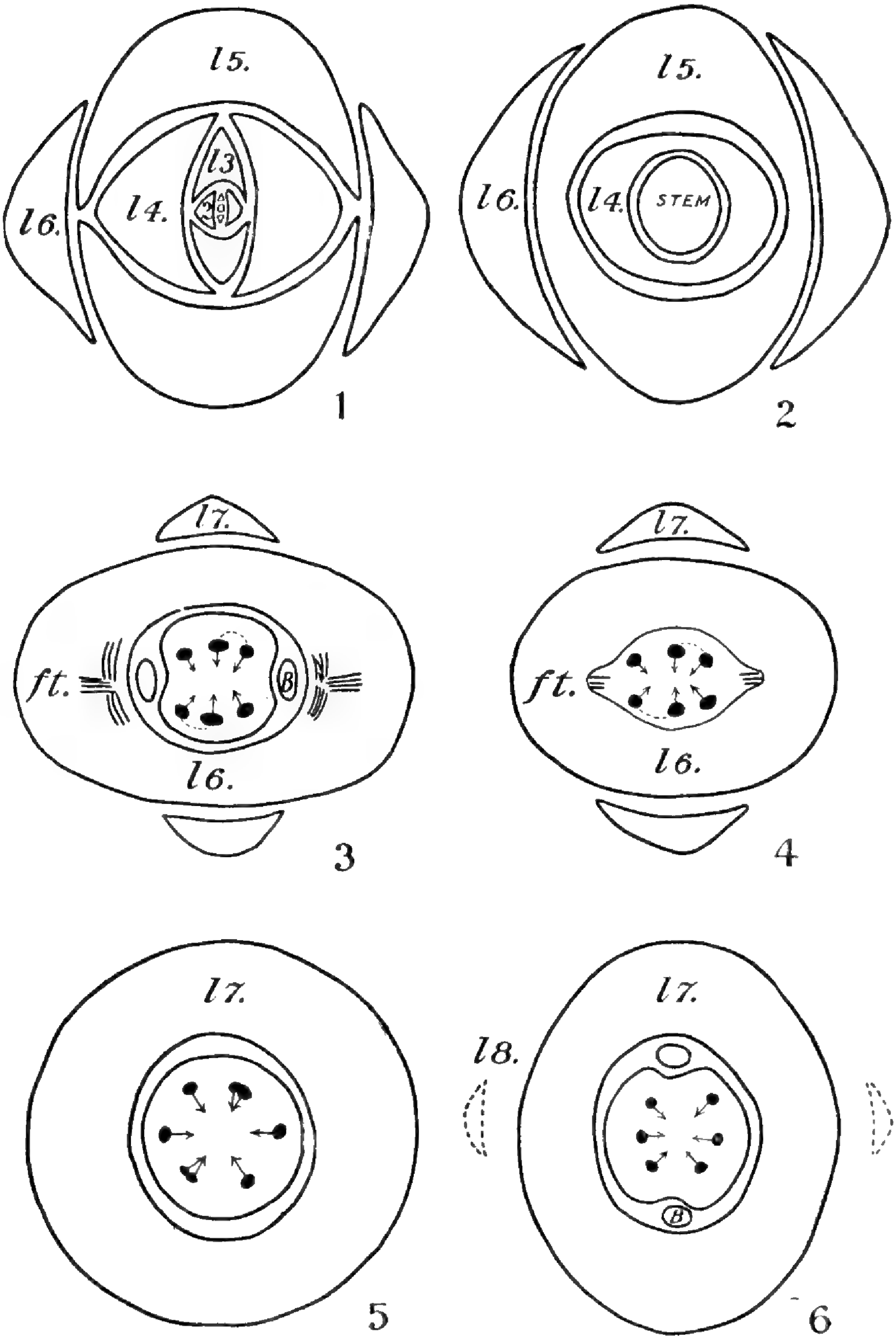
Salicornia perennis, Mill.

1=Transverse section near base of the internode.
2=Transverse section in the nodal region, just below 1.
3=Transverse section in the internode, below 2.

ls.A, *ls.B*=two foliar sheaths; *per.*=pericycle; *end.*=endodermis; *ep.*=inner epidermis of foliar sheath; *f.t.*=foliar trace.

The bundles of the foliar sheath are omitted; the vascular bundles of the stem are represented by black dots.

Fig. 3.



Salicornia perennis, Mill.

Transverse sections through a young vegetative shoot.
l. = leaf; *ft.* = foliar trace; B = bud.

The occurrence of the spiral and spicular cells which are found in many species will be dealt with later.

The vascular supply of each leaf is provided for by the passing out of a single bundle from the central stem cylinder. Immediately the leaf-sheath is reached the trace divides into three equal strands (*f.t.* text-fig. 3, **3**); the median one passes obliquely upwards, divides freely, and forms the numerous veins of the free leaf-tip ; the two lateral bundles pass obliquely outwards and curve downwards, branching repeatedly as they do so, and form the anastomosing network of bundles lying between the palisade layer and the aqueous tissue of the foliar sheath.

The small ultimate strands die out before the base of the internode is reached, so that the leaf-trace vascular system of one internode has no immediate connection with that of any other (text-fig. 4, p. 324).

In text-fig. 4, A–B shows one-half of the vascular tissue belonging to the two leaves whose apices are shown at *l1* and *l2*, the remaining half of the foliar bundle system cannot be shown in the diagram. B–C gives the complete vascular tissue of the leaf whose apex appears at *l3*, that of the opposite leaf of the pair, *l4*, lies in the plane of the paper. The ramifications of the foliar bundle *f1* show no anastomosing with those of *f2*, so that the network of bundles in the sheath is not "closed" completely, as is stated by Solereder *, but is, as Duval-Jouve † remarks, an "open" system. The individual strands of the leaf, both in its free and in its adnate region, are very small and show "reversed orientation" in a morphological sense, as has been pointed out by Fron ‡ ; Dangeard § makes the same statement for the "cortical bundles" of *Arthrocnemum fruticosum*, Moq.|| Although the orientation of the bundles is morphologically "reversed," the histological relations are normal, the phloem being directed towards the palisade, while the xylem lies nearest to the ventral surface (Pl. **15**. fig. 2). The morphological inversion of the bundle is brought about by the "rotation" of the strand derived from the outgoing leaf-trace, during its passage through the foliar sheath towards the palisade layer.

3. *The Structure of the Flowering Shoot.*

The flowering spike is constructed on the same general plan as the vegetative shoot. It consists of a series of decussately arranged bracts, in

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* Solereder, H.: Systematic Anatomy of the Dicotyledons. Trans. by Boodle and Fritsch, 1908.

† Bull. Soc. Bot. Fr. xi. (1866) p. 140.

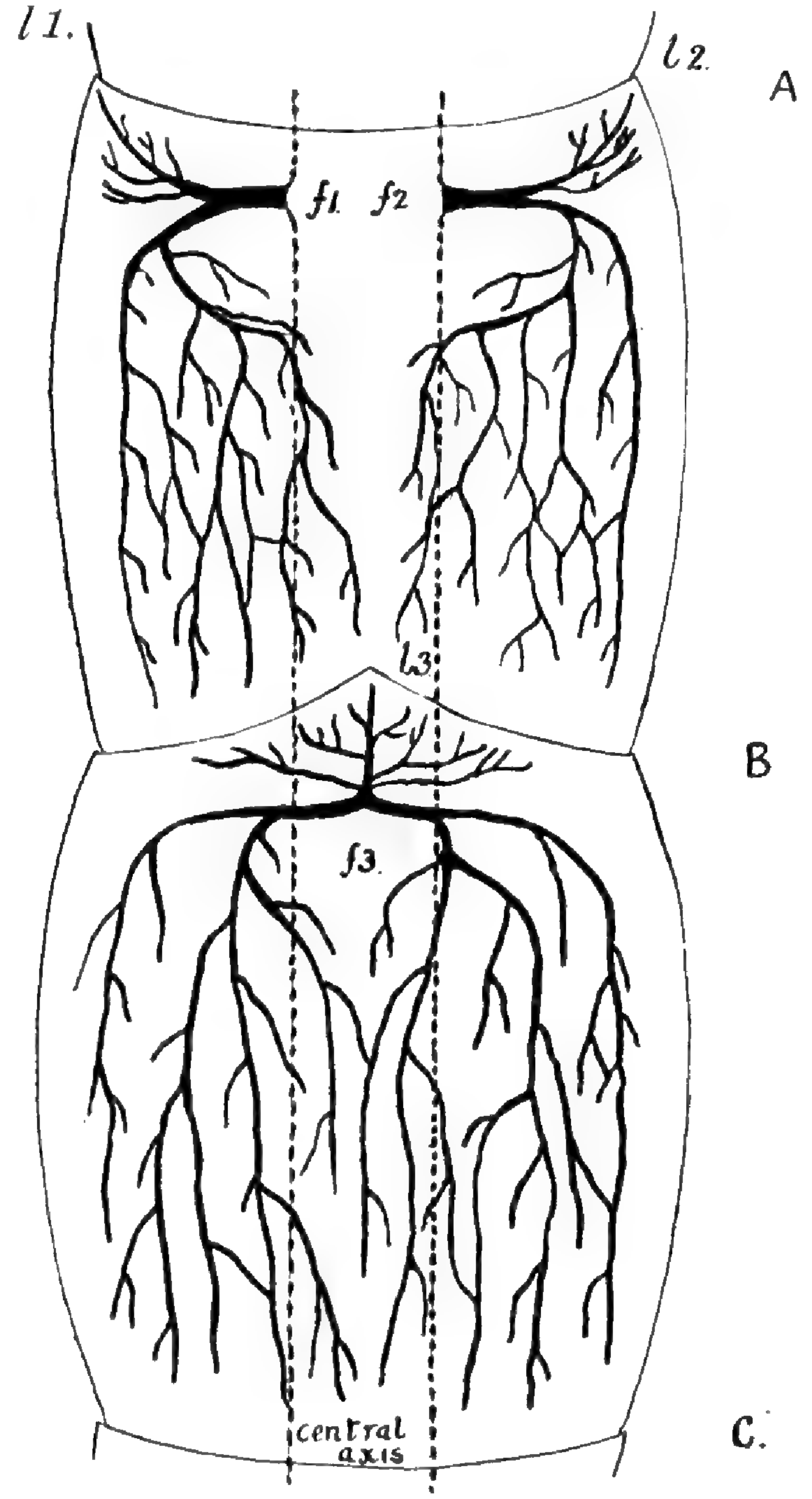
‡ Fron, G.: in Ann. Sci. Nat., sér. 8, Bot. t. ix. (1899) p. 157.

§ Bull. Soc. Linn. Normandie, sér. IV. ii. (1887) p. 188.

|| The *Arthrocnemum fruticosum* of Moquin-Tandon includes *Salicornia perennis*, Mill (=*S. radicans*, Sm.).

the axil of each of which is a sessile biparous cyme composed of three flowers, except in *S. disarticulata*, Moss, where only one is present. We have found no suggestion of the bracteole, said by Baillon * to occur in " *S. herbacea.*"

FIG. 4.



Leaf-trace vascular system of two internodes of a vegetative shoot of *Salicornia*.

A series of transverse sections through a flowering spike show that the pairs of bracts behave in exactly the same manner as the pairs of leaves of a vegetative shoot, for each pair is composed of two free bract-tips

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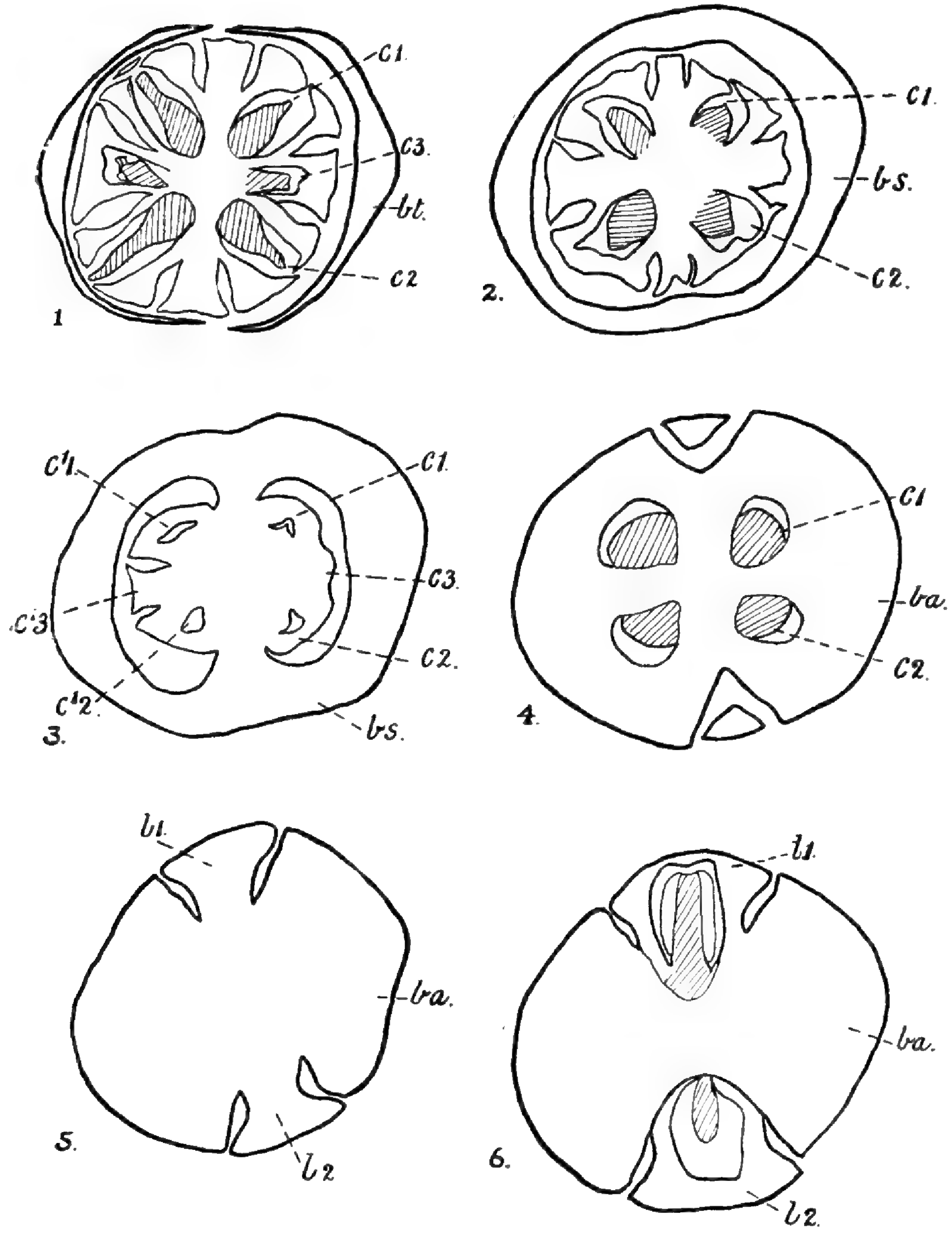
* Baillon, H.: Bull. mens. de la Soc. Linn. d. Paris, 1886, p. 620.

Fig. 5.



Transverse section of flowering spike of *S. perennis.* (All vascular tissue has been omitted.)

c.1, c.2, c.3 = flowers in the axil of one bract.

$c^1.1$, $c^1.2$, $c^1.3$ = flowers in the axil of the opposite bract.

bt. = bract tip ; *bs.* = bract sheath ; *ba.* = adnate bract sheath.

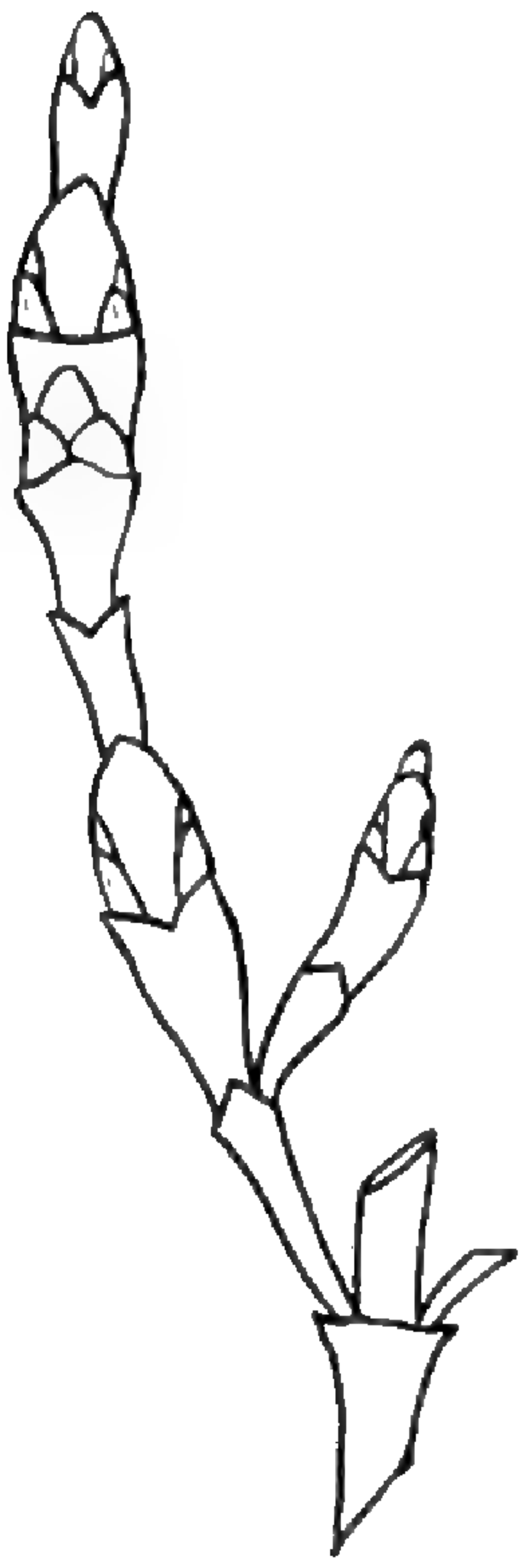
l1, l2 = parts of the two groups of flowers of the node below.

(*bt.*, text-fig. 5, **1**), fused bract-sheath (*bs.*, text-fig. 5, **2** & **3**), and adnate bract-sheath (*ba.*, text-fig. 5, **4–6**). The vascular supply of the bracts is also exactly comparable to that of the leaves, for two strands pass out at the node, one to each bract, each divides up into three, the median branch supplying the free bract-tip, the two lateral curving outwards and downwards, their branches supplying the fused, decurrent part of the bract. The three flowers of a cyme arise at the node, in the axil of the bract, as is illustrated in text-fig. 5, **3–4**, *c.1*, *c.2*, *c.3* representing the flowers of one bract, $c^1.1$, $c^1.2$, $c^1.3$ those of the second bract of the pair. The two lateral flowers arise lowest on the axis (*c.1*, *c.2*, text-fig. 5, **2–3**), the central one, *c.3*, being placed slightly above them. Owing to the lateral compression exercised by the two groups of flowers (*l.1*, *l.2*, text-fig. 5, **5–6**) of the node immediately below, the fused bracteal sheath again becomes two separate structures in the lower adnate region.

In connection with the close agreement between the bracts of the flowering spike and the leaves of the vegetative shoot, an interesting feature was observed in a plant of *S. herbacea*, collected at Cley (on the Norfolk coast). The whole plant was characterised by the possession of interrupted spikes of sterile and fertile segments. Text-fig. 6 illustrates one such spike.

The structure of the flowering shoot thus lends additional support to the foliar sheath theory of the succulent cortex of the Salicorniieæ.

Fig. 6.



Interrupted spike of sterile and fertile segments of *S. europæa.*

4. *The Leaf-fall.*

In the perennial species periodic shedding of the succulent, foliar sheath occurs in the autumn, while the annual forms similarly shed their foliar organs towards the close of their flowering period. The leaf-fall takes place in regular sequence, beginning with the foliar coating and extending upwards throughout the length of the shoot. Preparation for the defoliation can be detected at least three or four segments above the one in which it is actually taking place. The first sign of it appears in the gradual suberisation of the cells of the limiting layer of the stem tissue. As has already been pointed out, this layer is always sharply marked off from the foliar tissues by the size, shape, and regular arrangement of its elements (*cf. s.l.*, fig. 1, Pl. **15**). Suberisation, which begins in this cell-layer, extends inwards until the four or five outermost layers of tissue are affected. This condition is arrived at about three or four segments below the one in which suberisation can first be detected. The cell-walls of the aqueous tissue of the foliar sheath show at this stage a tendency to collapse, a little lower down the shoot they do so completely, and finally the sheath is torn or rubbed off, separation taking place in the innermost sheath layers (Pl. **15**. fig. 3).

5. *The Morphology of the Seedling.*

The seedling possesses two small fleshy cotyledons and a short thick hypocotyl (Pl. **15**. fig. 4, *a* & *b*). The seed leaves show no development of a palisade layer, but the aqueous tissue is well marked. The two cotyledons (*c.1*, *c.2*, text-fig. 7, **1** & **2**) fuse laterally towards their base and form a short cotyledonary tube or sheath (*c.s.*), in a manner precisely comparable to the leaf-sheath of the vegetative shoot in the mature plant; this tube finally unites with the hypocotyl and is decurrent down it as a succulent "cortex." The behaviour of the vascular strands of the cotyledons again exactly agrees with that of the foliar traces.

Two bundles pass out from the hypocotyl, one to each cotyledon; as soon as they leave the hypocotylar region each divides into three (*cb.1*, *cb.2*, text-fig. 7, **3**), the median strand of each branches and supplies the seed leaf with vascular tissue, the two lateral strands curve outwards and downwards into the hypocotylar "cortex," branch once or twice, the branches anastomose somewhat, and finally they die out towards the lower end of the hypocotyl (*h.c.b.*, text-fig. 7, **3** & **4**). The hypocotyl of the seedling is thus provided with a double series of bundles, an inner hypocotylar ring (reinforced in older series by the epicotylar strands), and an outer series also of cotyledonary origin. There is thus absolute agreement between the behaviour of the vascular strands in the three foliar categories of leaves, bracts and cotyledons.

6. *The Morphology of Species of Allied Genera.*

Among the various genera placed by Volkens * in the group Salicornieæ, many are described as jointed and apparently leafless; the following genera are included in this class—*Spirostachys*, *Halostachys*, the long shoots of *Halocnemum*, *Tecticornia*, *Arthrocnemum*, *Salicornia* and *Microcnemum*. Fresh material not being available, herbarium specimens of representatives of the remaining genera, with the exception of *Heterostachys*, were examined. In *Kalidium foliatum* alternately arranged leaves exist; these leaves are small and are characterised by the decurrence of the leaf-base, which extends from the node, down the stem to the internode below. *K. arabicum* shows a similar decurrence of the leaf-base, but the fused part appears almost tubular, extending more than halfway round the stem. The leaves of

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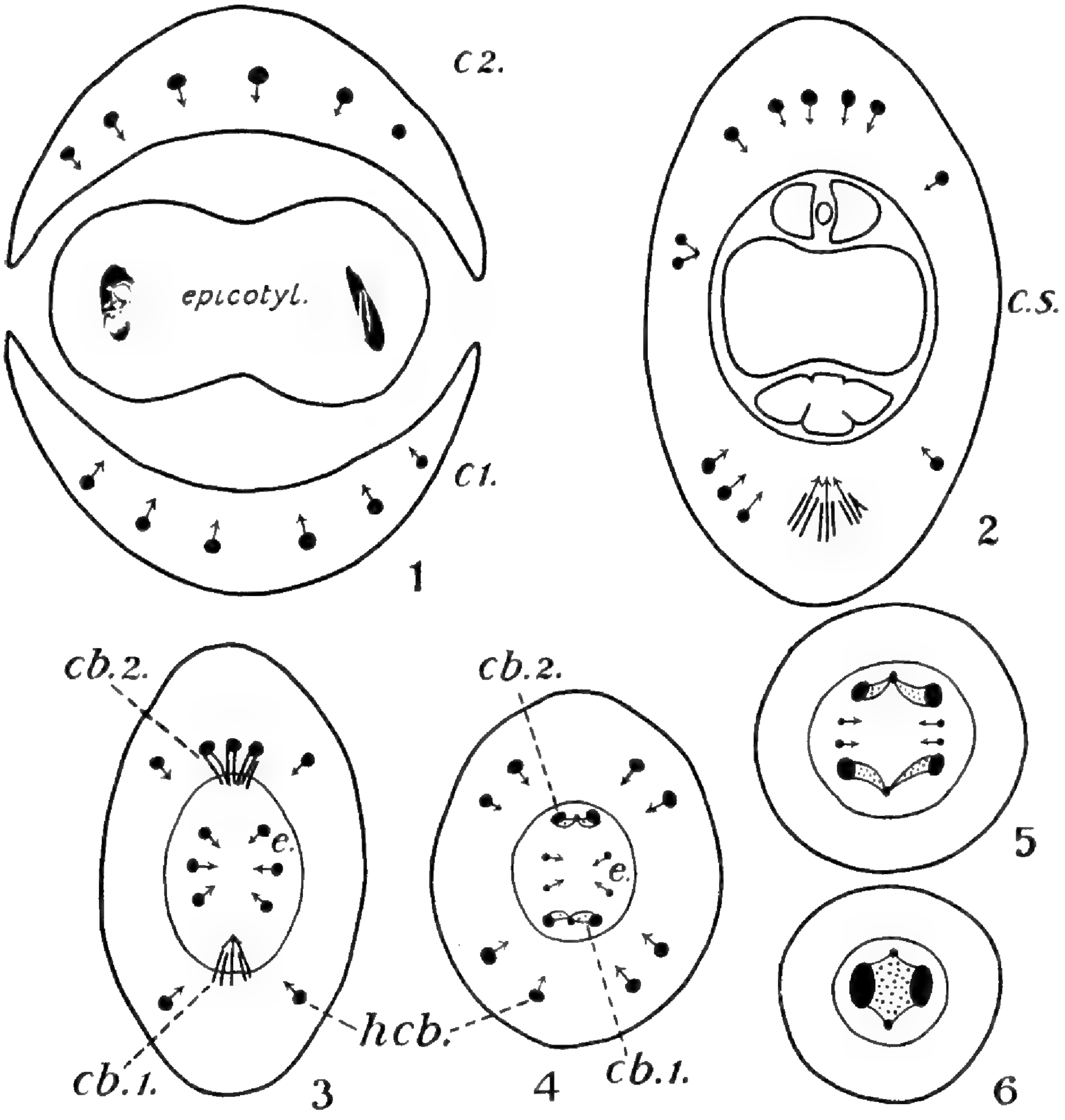
* Engler & Prantl, Natürlichen Pflanzenfamilien, Teil iii. Abt. 1 A (1894).

Halopeplis amplexicaulis and *Halostachys perfoliata* seem to resemble those of *Kalidium foliatum*. If the leaves of these species were opposite instead of alternate, and if the margins of the adnate foliar bases were fused, then there would result a structure externally like that found in *Salicornia*. These genera certainly suggest strongly a possible method by means of which the *Salicornia* condition arose. We were unfortunately unable to secure material for an anatomical examination of these forms, but through the kindness of Mr. Tansley, who generously placed at our disposal some material

FIG. 7



Salicornia prostrata var. *Smithiana*, Moss.

c.1, *c.2*=cotyledons ; *c.s.*=cotyledon sheath ; *c.b.*=cotyledon bundle ; *h.c.b.*=hypocotyledonary bundle ; *e*=epicotyledonary bundle.

collected by him *, we were able to investigate the morphology and anatomy of the vegetative structures of one species of the remaining genus *Halocnemum*.

Halocnemum strobilaceum, Bieb., shows the feature, unique among the Salicornieæ, of the differentiation of long and short shoots. The long shoots of the plant (Pl. **15**. fig. 5) were covered with small, fleshy rosette-like structures, which at first sight strongly resemble flower buds. These rosettes are decussately arranged upon the long shoot, each consists of four or five pairs of opposite fleshy leaves, each pair alternating with the pair above (Pl. **15**. fig. 5). The leaves in a rosette show no trace of lateral fusion, and adnation is impossible owing to the extreme reduction of the internodes in the crowded bud, for the rosettes are merely leaf buds in which the leaves are succulent; the short shoots originate by the further development of these buds (*cf.* Pl. **15**. fig. 6). The young short shoot is made up of jointed segments very similar to those of a Salicornian shoot †, each segment of the axis having two free tips, a free sheath, and an adnate foliar sheath just as in the genus *Salicornia*. The transition between the free leaves of the rosette which remain at the base of the shoot, and the fused adnate leaves of the segments, takes place gradually, and the two appear to be undoubtedly morphologically identical. The "succulent cortex" in the very closely allied genus *Salicornia* is strictly homologous with that of *Halocnemum strobilaceum*. In the latter species (as is shown later on in the paper) it is undoubtedly foliar in origin, so that it must be considered as of morphologically foliar nature in the former genus also. In the older short shoots each leaf bears in its axil a bud, the two buds of the pair of leaves extending round the whole circumference of the stem (Pl. **15**. fig. 7). The close agreement between these axillary buds and the rosettes of the long shoots, both as regards arrangement and anatomy, leaves no doubt that the latter represent the former in an older stage of development, thus the "long shoots" with their decussately arranged rosettes represent the older "short shoots" in which the leaves have fallen, leaving only the axillary buds to clothe the stem.

Thus it would appear that for developmental reasons, on anatomical grounds, and in comparison with nearly allied genera, the "succulent cortex" of the genus *Salicornia* must be considered as foliar in origin.

It may be well to state in this connection that although we believe that the bulk of the Salicornian shoot is foliar in origin, yet we do not consider that this fact should be used as evidence in favour of the "phyton theory" which has been used to explain the origin of the leaf of higher plants. We regard the Salicornian condition as a specialisation or a secondary adaptation which has resulted entirely on account of the physiological needs of the plant. The genus *Salicornia* is composed entirely of pronounced halophytes, leaf reduction may have occurred in response to the environmental requirements of the plant, then, to provide the necessary assimilation surface the broad bases of the sessile leaves fused and became decurrent down the stem, thus giving rise to the curious jointed shoot of the group.

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* At the mouth of a shallow wadi opening on to the Gulf of Suez, in April 1901.

† The resemblance to *S. glauca* is very close.

SPIRAL CELLS AND STEREIDES.

A very characteristic feature in the anatomy of many species of *Salicornia* is the occurrence of spiral, or spicular cells, or both.

The *spiral cells* are large, sac-like, colourless elements which occur wedged in between the palisade cells of the assimilating layer of the foliar organs, their long axis parallel with the palisade cells (Pl. **15**. fig. 8). The cell wall of these elements is thin and is composed of cellulose, though in a very few cases in *S. fruticosa*, Linn., a slight trace of lignification has been observed. A closely wound spiral thread of cellulose lines the inner wall and reaches nearly to the rounded ends of the elements. The length of the spiral cells is very variable ; in the lower parts of the segments they are short and rarely extend much beyond the palisade layer, but in the upper region of each segment, in the free leaf-tips, and especially in the flowering spike, they are frequently extremely long. The epidermis is rarely reached by the spiral cells, and the relation between them and the stomata does not appear to be a definite one. In this connection, however, Duval-Jouve * states that "elles sont constamment situées ou directement au-dessous ou tout à côté d'un stomate, mais non en contact." This position does occasionally occur, but it is by no means a constant characteristic of any of the species we have examined. Mangin †, likewise, does not agree with Duval-Jouve's observation, for he found that spiral cells were often separated from the epidermis by a parenchymatous cell. He further noted the occurrence of protoplasm and a nucleus in many of them, and traced their development from elements of the chlorenchyma. Spiral cells are never directly connected with the vascular bundle system.

The distribution of the spiral cells in the various parts of the plant seems to be similar in all the species in which they occur. The basal region of the segment is always destitute of them, in the middle region they begin to appear, and increase in number until the free leaf-sheath is reached, in which position they are most abundant. In the reproductive shoots the spiral cells attain their maximum development, both as regards size and number. They are found in the flowering spikes of such species as *S. prostrata, S. herbacea,* and *S. pusilla*, though the vegetative shoots are generally destitute of them ; in *S. prostrata* var. *Smithiana* they are found only in the reproductive spikes. Seedling plants of *S. perennis*, its variety *lignosa*, *S. prostrata* var. *Smithiana*, and *S. ramosissima* have usually no spiral cells, in the first two species they do not usually appear to develop in the first year of growth at all *.

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* Bull. Soc. Bot. France, xv. (1868) p. 134.

† Mangin, L. : "Sur le développement des cellules spiralées." Bull. Soc. Bot. France, xxix. (1882) p. 16.

Finally, in *S. Emerici* †, Duval-Jouve [= *herbacea*] ‡, that author states that the spiral cells are few and ill-formed ; we are entirely in agreement with the first statement, for the elements are often absent in the vegetative shoot, yet when present we find that they show no difference in formation from those of other species.

Spicular Cells or Stereides.

In *S. glauca*, Del.§ spiral cells are absent, but they are replaced, as far as position is concerned, by stereides (Pl. **15.** fig. 9). These are long, slightly branched elements with thick lignified walls, freely perforated by simple pits. They occur, as do the spiral cells, in the palisade region, and usually do not extend far into the aqueous tissue, they are extremely abundant, as are the spiral cells of *S. fruticosa*, Linn.

According to Monteil ||, *S. macrostachya*, Moric. (= *S. glauca*, Del.) possesses both spiral cells and stereides in its palisade region, and he figures a specimen in which the latter occur mixed with short spiral cells. We have been unable to find this association of spiral and spicular cells in the same region, although we have examined material from four sources ¶. It is possible that Monteil worked on some form or species which was not available to us.

In *S. glauca*, Del. in addition to the stereides which occur so abundantly in the palisade region, there is an abundant development of similar elements round the vascular cylinder of the stem, just below the nodal region, and also in the free leaf-tips, parallel with, and just inside the epidermis of the ventral surface. Stereides are also abundant in the reproductive shoots.

In *S. fruticosa*, Linn., the stereides are replaced by spiral cells in the palisade region, but stereides occur in the other regions similar to those of *S. glauca*.

In *S. perennis*, Mill., *S. lignosa*, Woods, and *S. disarticulata*, Moss, a few broad, short stereides occur in the reproductive shoots, especially at the base of the flower, while finally, in *S. gracillima*, Moss, the flowering spikes are abundantly supplied with stereides which are almost isodiametric.

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* In *S. perennis* only one spiral cell was found in all the first year material examined.

† *S. Emerici*, Duval-Jouve = *S. stricta*, Dum. = *S. herbacea*, Linn. forma *stricta*, Moss.

‡ Bull. Soc. Bot. Fr. xv. (1868) p. 177.

§ *S. glauca*, Del. = *Arthrocnemum macrostachyum*, Bunge.

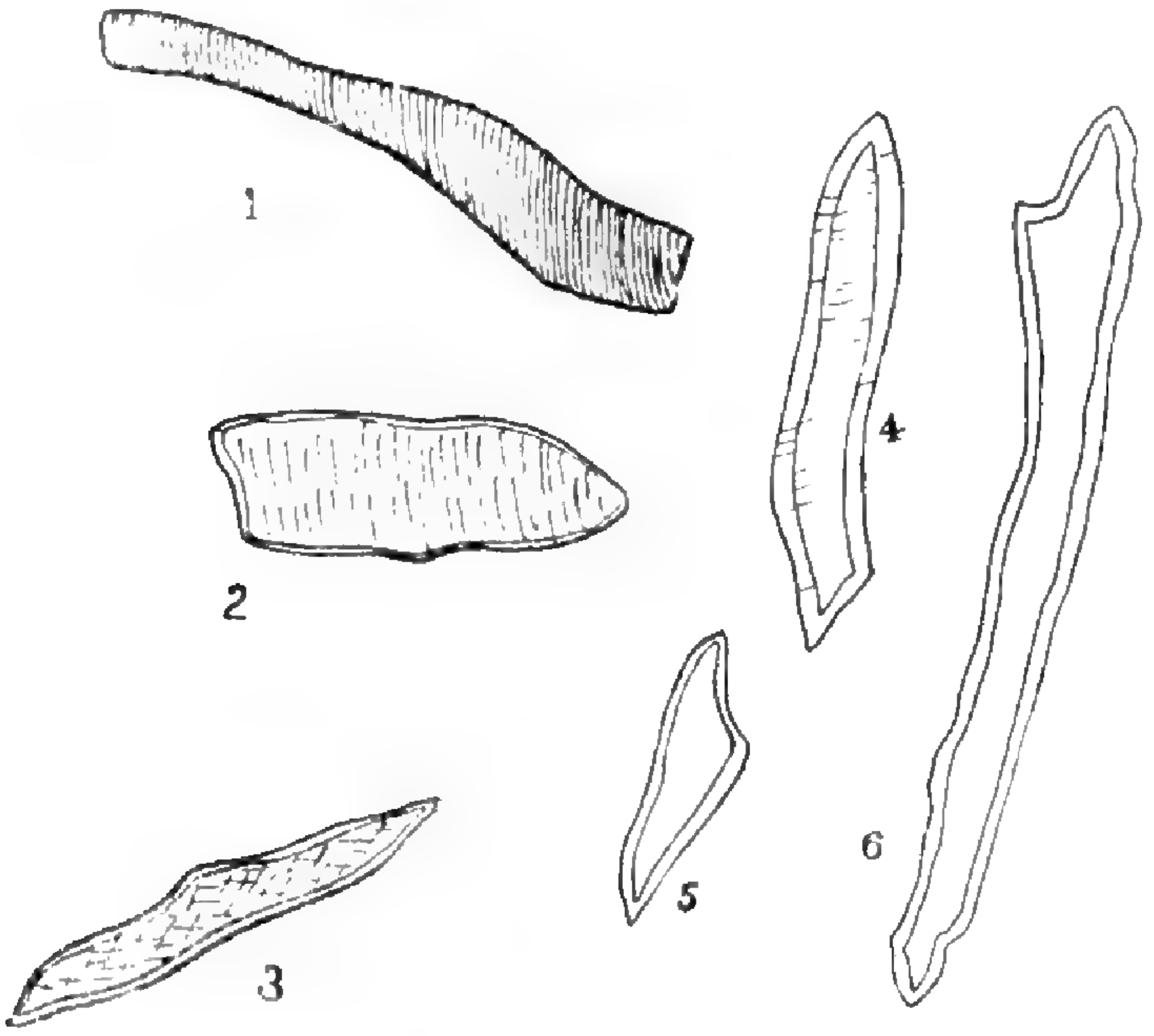
|| Monteil, Anat. Comp. Feuille des Chenopodiacées, 1906, p. 130, fig. 41.

¶ Algeria, S. France, Palestine ; British Museum Herbarium.

With regard to the relationship existing between the spiral and spicular cells, we consider that the two are homologous structures. In *S. lignosa* spiral cells are very abundant in the fruiting spikes; interspersed with them are cells of precisely similar form, but with slightly thickened cellulose walls with long narrow pits. Practically every stage occurs between the stereides with simple pits, the cells with thickened cellulose walls with simple pits, and the similar shaped cells with very long, narrow pits, the latter very closely resembling in appearance the spiral cells of normal type.

Finally, in *S. fruticosa*, Linn., the walls of the spiral cells are sometimes slightly lignified. *S. perennis* also shows fairly numerous transitional forms, and one or two such have been observed in *S. Oliveri* (text-fig. 8).

FIG. 8.



1–5. *S. perennis* var. *lignosa*, Moss. 6. *S. glauca*, Del.

1. Spiral cell, × 80; 2–3. Transitional cells, × 80; 4–6. Stereides, × 175.

The precise function which is served by spiral cells is difficult to determine, and many explanations as to their use have been given by different investigators. Duval-Jouve* states that they are always filled with air, and on this account he calls them "cellules aérifères, sans autre intention que celle de les nommer, et sans rien préjuger sur la fonction que semble indiquer leur position entre les stomates et le reseau fibro-vasculaire, ainsi que leur substitution aux lacunes à air." Monteil† appears to follow Duval-Jouve in his suggestion as to the function which they serve. Mangin‡ came to the

* Bull. Soc. Bot. Fr. xv. (1868) p. 140.

† Anat. Comp. Feuille des Chenopodiacées, 1906, p. 126.

‡ Bull. Soc. Bot. Fr. xxix. (1882) p. 16.

conclusion that they might be considered as "organes de soutien," and stated that "elles remplissent alors le rôle des cellules allongées à cloisons épaissies, qui constituent les cordons fibreux des Palmiers, des Pandanées, ou qui forment le gaîne externe du corps central de beaucoup de hampes florales." Van Tieghem * also considers that these elements are part of the cortical stereome.

Holtermann † describes the occurrence of spiral cells in *Arthrocnemum indicum* "die die Wasserzufuhr nach den peripherischen Teilen besorgen."

Volkens ‡ and Solereder § both state that they serve the purpose of water-storage.

Finally Warming ‖ expresses his opinion thus:—"These water-storing tracheids seem to play the same rôle as do wood-vessels in vascular bundles, since they fill with water and give it up again without collapsing."

Our own observations lead us to consider that the tracheids are water-storing elements, and their abundance in the foliar sheath at the nodal region, and in the reproductive shoots, is in accordance with this view.

The function of the stereides needs no discussion, for they are obviously part of the mechanical support of the plant. In their position and in their characteristics they closely resemble the similar elements found in the leaf of *Hakea suaveolens.*

Summary of the Distribution of the Spiral Cells and Stereides in the species of *Salicornia*.

I. STEREIDES ONLY.
    S. glauca, Del.

II. STEREIDES AND SPIRAL CELLS. (The latter only in the palisade region).
    a. Stereides in both vegetative and reproductive shoots.
        S. fruticosa, Linn.
    b. Stereides in reproductive shoots only.
        S. perennis, Mill.
        —— var. *lignosa*, Moss.
        S. disarticulata, Moss.
        S. gracillima, Moss.

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* Van Tieghem, P.: Traité de Botanique, p. 742.

† Holtermann, C.: Der Einfluss des Klimas, 1907, p. 85.

‡ Engler u. Prantl, Nat. Pflanzenfam. Teil iii. Abt. 1 A (1894), pp. 73–78.

§ Syst. Anat. Dicot., Engl. Trans. 1908, ii. p. 1093.

‖ Warming: Œcology of Plants, 1909, p. 126.

III. SPIRAL CELLS ONLY.

a. Always very few. Very often entirely absent in the vegetative shoots.

S. pusilla, Woods.
S. ramosissima, Woods.
S. appressa, Du Mort.
S. herbacea, Linn.
S. prostrata, Pall.

b. Absent in the vegetative shoots. Few in the reproductive shoots.

S. prostrata var. *Smithiana*, Moss.

IV. STEREIDES AND SPIRAL CELLS ABSENT.

S. Oliveri, Moss.
S. dolichostachya *, Moss.

THE STEM.

Primary Structure.

The primary vascular cylinder of the stem is built up entirely of leaf-traces; in the upper region of the internode eight open collateral bundles are found, this number being reduced to six before the node below is reached.

The course of the bundles in the stem of *Salicornia perennis* is very simple: one foliar trace enters the stem from each leaf at the node; it very rapidly enters the central ring of primary bundles and then passes vertically downwards through one complete internode and the upper part of the internode below, fusion with the adjacent bundle then takes place. The course of the primary bundles can be more readily understood by reference to text-fig. 9, which represents the central vascular system of three internodes laid out flat.

We examined the course of the primary bundles in a young plant of one of the annual species (probably *S. prostrata* var. *Smithiana*), and found the resemblance to that of the perennial *S. perennis* was very close. It was strikingly different from that described by Fron † for "*S. herbacea*, L."

According to the latter observer the entering leaf-trace passes vertically down an internode, but immediately above the node it bifurcates, after the node is passed each of the bundles thus formed fuses with the adjacent vascular bundle; throughout the greater part of the internode the primary vascular ring consists of six bundles, just before the node is reached the bifurcation of the two leaf-traces increases the number to eight, immediately below the node the two entering leaf-traces increase the vascular strands to ten, but the number is soon reduced to six by the fusions above described.

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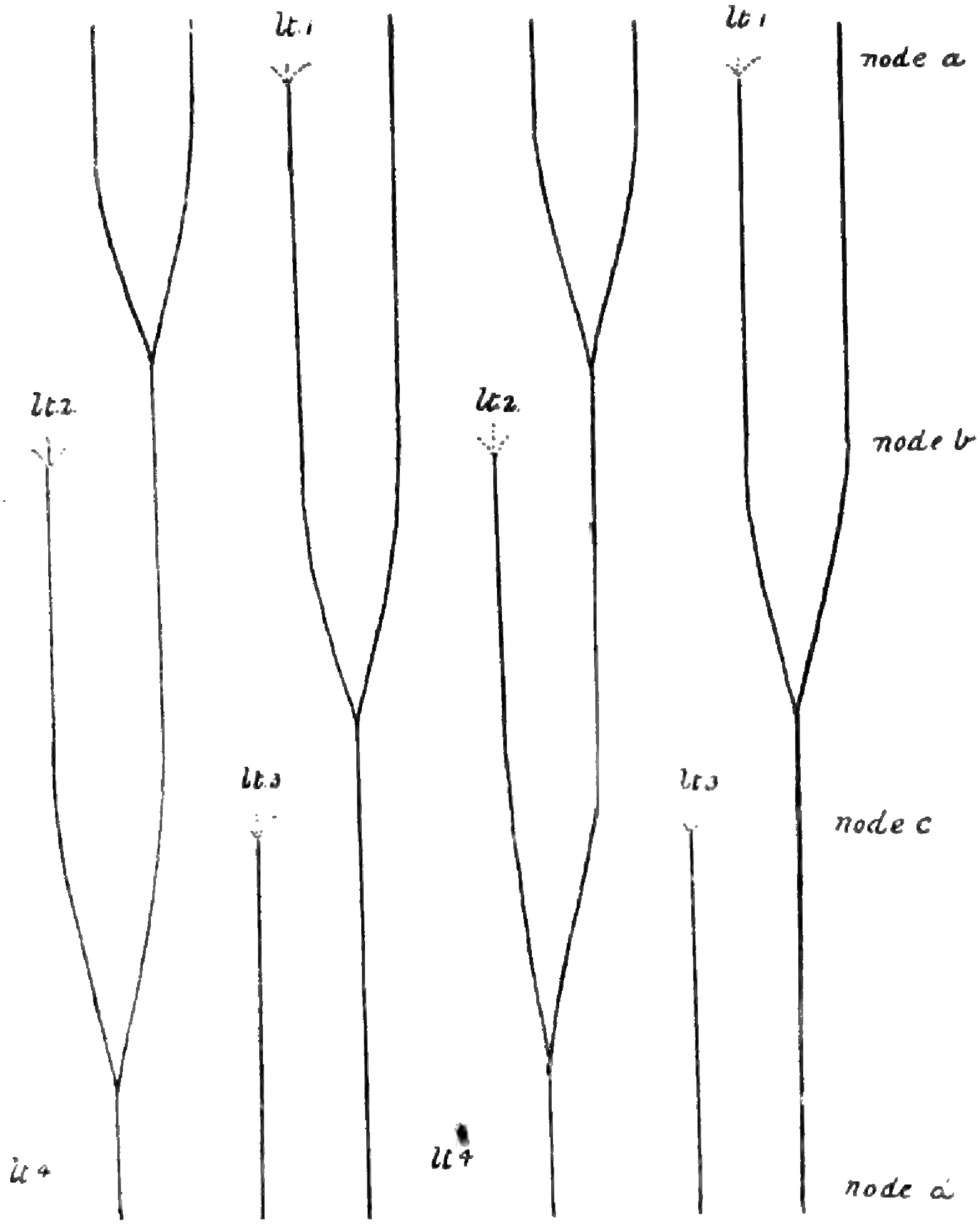
* The specific characters of this species have been described by Dr. Moss in the 'New Phytologist,' xi. (1912) p. 409.

† Ann. Sc. Nat. sér. 8, Bot. ix. (1899) p. 157.

The vascular cylinder of the stem surrounds a pith composed of small parenchymatous cells; in most of the species it is of small extent, and is almost negligible compared with the ring of vascular tissue; in the prostrate stem of *S. Oliveri*, however, it is of considerable extent, and frequently a medullary cavity is formed; the contrast between the stem of this species and that of *S. perennis* and *S. lignosa* is in this respect very marked.

FIG. 9.



S. perennis, Mill. Primary vascular bundle system of the young stem.
lt. = foliar trace.

The pericycle, composed of two or three layers of cells, is surrounded by an endodermis, which forms the "limiting layer" between the stem tissue and the foliar sheath; primary cortex is absent, but a more or less extensive secondary cortex may be produced by the activity of the secondary cambium.

Secondary Structure.

The cambium of the primary bundles is functional for a very short time only, and the zone of secondary tissue which forms the bulk of the mature stem, is due entirely to the activity of a secondary meristem. At a very early stage a cambium arises in the pericycle immediately opposite the primary bundles (Pl. **15.** fig. 10); these isolated arcs of meristematic tissue are rapidly joined up, so that a complete ring of cambium surrounds the primary bundle-system. On its inner side this meristematic layer gives rise to strongly lignified, prosenchymatous ground-tissue, and at certain points groups of vessels. Where these latter are formed, the cambium on its outer side produces a group of phloem elements; as the neighbouring cells continue the formation of the lignified ground-tissue on the inner side, this phloem bundle (on a radial line with the vessels) soon becomes embedded (Pl. **15.** fig. 11), its cambium then ceases its activity, a new cambial arc joins up the broken ring outside the embedded phloem, and the formation of lignified ground-tissue is resumed. The collateral bundles thus formed become completely surrounded by the fibres of the intermediate tissue (Pl. **16.** fig. 12). As this anomalous secondary growth proceeds with comparative rapidity, an old stem shows a considerable thickness of lignified tissue in which the collateral vascular bundles are arranged in more or less regular concentric zones.

The outer side of this secondary cambium is usually inactive, or at most gives rise to two or three layers of cortical cells. An exception to this occurs in the regions associated with the formation of aerenchyma, but will be described later in connection with that tissue.

With regard to the anomalous secondary thickening in the stem and root of *Salicornia*, we find ourselves in complete agreement with the account given for the root by Fron * and for the stem by Solereder †. The account of the phenomena given by De Bary ‡ for "*S. herbacea*" differs in some respects, for he describes an extrafascicular cambium which "remains permanently active, and forms on its inner side alternately collateral vascular bundles and intermediate tissue, on its outer side a thin layer of bast, consisting only of parenchyma, or even no bast at all." In the rhizomes of the perennial species, and in the stem of *S. Oliveri*, the pericycle gives rise to a cork cambium, the activity of which produces externally a layer of cork seldom more than six cells in thickness; on its inner margin it may contribute slightly to the secondary cortex. A full account of the details of the cork development in *Salicornia herbacea*, Linn., is given by Leisering *, who traces its origin from the outer layer of the pericycle, the inner layer he regards as the seat of origin of the extrafascicular cambium. We are in agreement with these statements, but are unable to confirm his observation that the plant lacks leaves, for reasons which have been detailed already.

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* Ann. Sc. Nat. sér. 8, Bot. ix. (1899) p. 157.

† Syst. Anat. Dicot., Engl. Trans. 1908, ii. p. 1137 etc.

‡ Comp. Anat. Phaner. and Ferns, Engl. Trans. p. 590.

THE ROOT.

The primary root is always diarch in structure, and has always a very well marked endodermis (Pl. **16.** fig. 13). Even the youngest roots have a well formed aerating zone in the cortex; this zone consists of a large intercellular space bridged over at intervals by long narrow trabeculæ.

The primary condition of the root is maintained for a very short time, and anomalous secondary growth begins even in the seedling root (Pl. **16.** fig. 13). It is of exactly the same type as that previously described for the stem.

AERENCHYMA.

At the extreme base of the main stem in *S. fruticosa*, *S. herbacea*, *S. pusilla*, *S. prostrata* var. *Smithiana*, *S. ramosissima*, and *S. gracillima*, and at the base of the aerial shoots and on the rhizome of *S. perennis*, *S. perennis*, var. *lignosa*, and *S. Oliveri*, the secondary cambium gives rise on its outer side to an aerating tissue of more or less considerable extent. The roots of these species, especially the thicker ones, also show a similar formation.

In *S. pusilla*, *S. prostrata*, and *S. fruticosa* the zone of aerating tissue is of small extent and consists of rounded parenchymatous cells with a great development of intercellular spaces.

In *S. perennis* and *S. lignosa* the basal segments of the lateral shoots show the beginning of the aerating cortex even before the fall of the foliar sheath has been accomplished. These two species show at this stage the aerating zone made up of rows of rounded cells, very regularly arranged, with intercellular spaces between each row.

At the base of the main stem and in the upper part of the main root of *S. herbacea* and *S. ramosissima* the aerating zone reaches its maximum, and these two species are characterised by the possession of a spongy coating of aerenchyma in the parts named. The tissue consists of very thin walled parenchymatous cells, with cellulose walls; the cells, which are generally longer than they are broad, are arranged in irregular rows. In transverse section the cells, which are drawn out at either end, thus diminishing the contact area, appear to be covered with large pores (text-fig. 10). Radial sections through the tissue show that the irregular rows are connected with one another by means of tubular outgrowths, one or more arising from each

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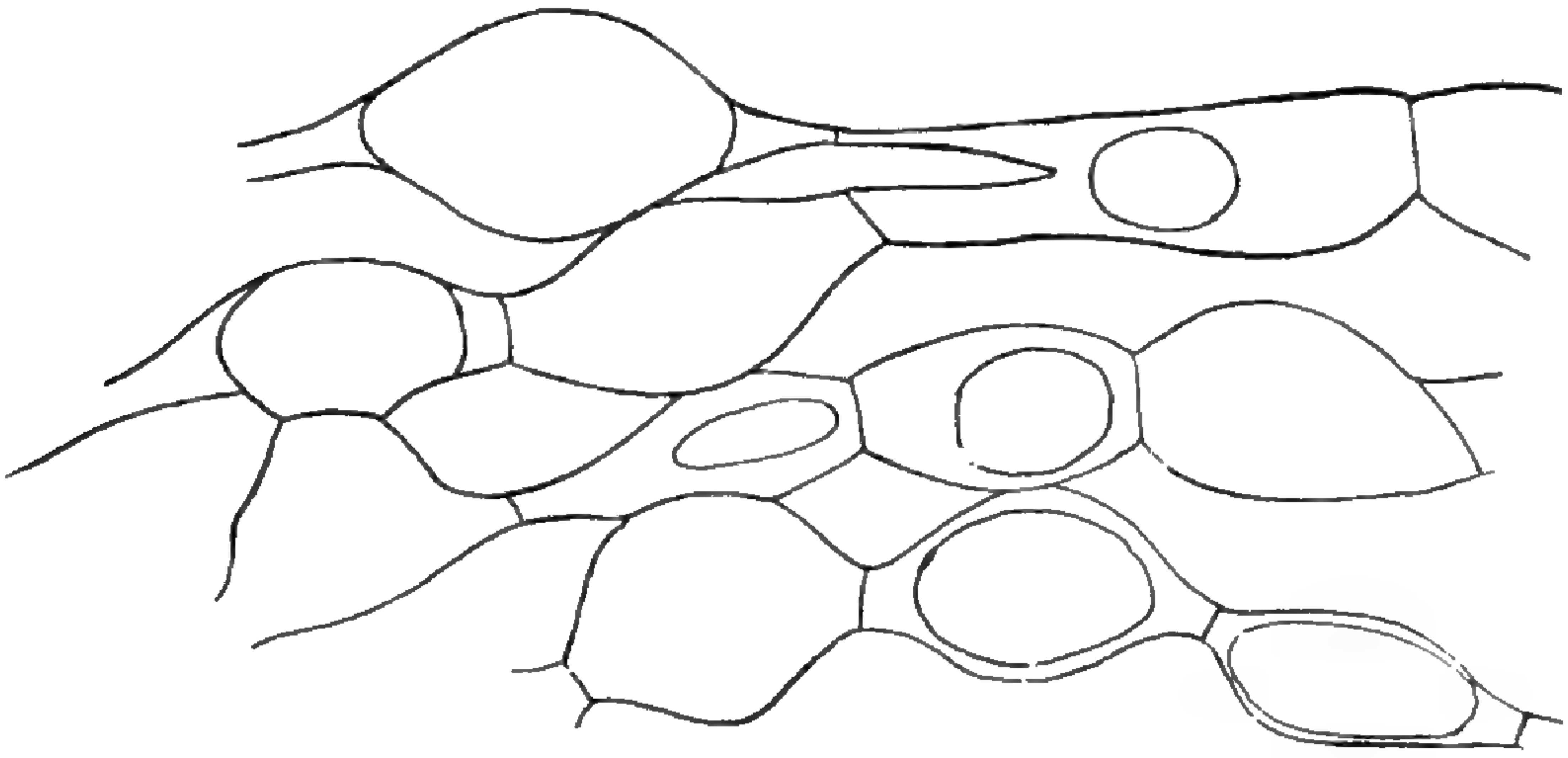
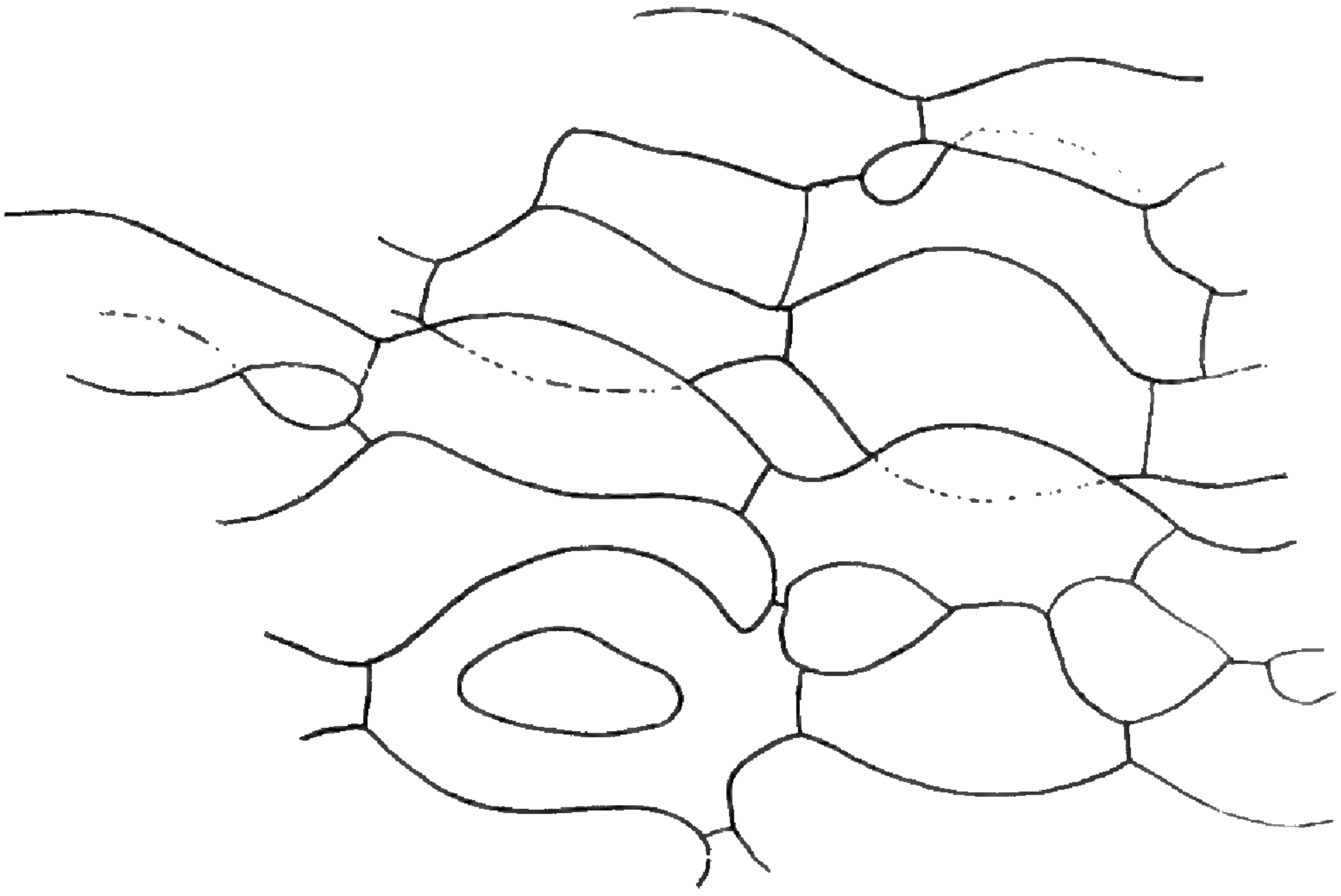
* Leisering, B.: "Über die Korkbildung bei den Chenopodiaceen," Ber. d. deutsch. Ges. xvii. (1899) p. 251.

Fig. 10.



Transverse section of the aerenchyma of *S. herbacea*, Linn. × 290.

Fig. 11.



Radial longitudinal section of the aerenchyma of *S. herbacea*, Linn. × 290.

cell, where these outgrowths are cut across a large rounded opening appears (text-fig. 11).

The tubular outgrowths serve to connect up the loosely arranged cells in such a manner as to provide the largest possible intercellular air space system. The tissue thus described differs in various details from that of any aerenchyma previously recorded. It approaches that figured by Schenck* for *Epilobium hirsutum*, but differs in the more regular arrangement of the rows of cells and in the method of connection of the rows one with another; in the latter feature it recalls *Jussieua peruviana*. On the whole the tissue is intermediate between the two types described by Schenck. The tubular outgrowths on the aerenchyma cells of *Salicornia* closely resemble those described by Schenck† as occurring on the "Markstrahlzellen" of the secondary phloem in the aerotropic roots of *Laguncularia racemosa*.

In all the cases in which aerenchyma was developed in the species of *Salicornia*, it was completely surrounded by a thin layer of cork. Since the material was not collected until September it seems unlikely that the aerenchyma, in the annual forms at any rate, ever becomes freely exposed, as is the case in so many plants in which the tissue is produced. A similar feature is recorded by Witte‡ as occurring in *Lysimachia vulgaris*, L. In *Salicornia europæa*, in which the development of the tissue reached the maximum dimensions, the outer tissues are very readily torn off, and in cutting sections it is almost impossible to retain them in position (Pl. **16**. fig. 14). *S. ramosissima* shows a development of the aerenchyma in ribs on the stem.

We have throughout given the name of aerenchyma to this air storing tissue of *Salicornia*, in agreement with the definition of the tissue given by Haberlandt§, Goebel‖, and Gerschon Seliber¶, though according to Schenck** the name should be restricted to an aërating tissue formed from a cork cambium.

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* Schenck, H.: "Über das Aërenchyma, ein dem Kork homologes Gewebe bei Sumpfpflanzen." Pringsh. Jahrb. f. wiss. Botanik, Bd. xx. Berlin, 1889, pp. 526–574, pl. 23–28.

† Schenck, H.: "Über die Luftwurzeln von *Avicennia tomentosa* und *Laguncularia racemosa*." Flora, 1889, Heft 2, p. 88.

‡ Witte, H.: "Über das Vorkommen eines aërenchymatischen Gewebes bei *Lysimachia vulgaris*, L." Kjell. Bot. Studier, Uppsala, 1906, p. 265.

§ Haberlandt, G.: Physiologische Pflanzenanatomie, Leipzig 1896, p. 382.

‖ Goebel, K.: Pflanzenbiologische Schilderungen. II. Marburg 1891, p. 256.

¶ Gerschon Seliber: "Variationen von *Jussieua repens* mit besonderer Berücksichtigung des bei der Wasserform vorkommenden Aërenchyms." Abh. der Kais. Leop.-Carol. Deutsch. Acad. der Naturforscher, Bd. 84, Halle 1905, p. 43.

** Schenck, H.: Pringsh. *loc. cit.* p. 527.

THE SEEDLING.

The morphology of the seedling and its most important anatomical characters have already been described. The transition from stem to root structure takes place high up in the hypocotyl and is of Van Tieghem's type III. The cotyledons each contribute one bundle to the hypocotyl (*cb. 1* and *cb. 2*, text-fig. 7, **3**), almost immediately bifurcation takes place in the phloem, the metaxylem separates into two parts, and the half bundles thus formed rotate round the protoxylem until the latter is brought into the exarch position (text-fig. 7, **4** and **5**). The adjacent phloem groups next fuse, metaxylem elements are differentiated, and a typical diarch root is produced (text-fig. 7, **6**). Epicotyledonary strands may or may not be present according to the age of the seedling, but they play no essential part in the transition.

HALOCNEMUM STROBILACEUM, *Bieb.*

The morphology of this interesting plant has already been considered at some length, in connection with the discussion of the Salicornian foliar sheath, so that only a description of its anatomical features will be given here.

The Stem.

The primary vascular system of the stem is built up of leaf-trace bundles. Anomalous secondary thickening, of a type similar to that described for the Salicornieæ, sets in very early, rapidly producing a thick zone of lignified tissue in which the secondary vascular bundles are embedded. The cortical region is limited to a few cell-layers, and in the material available there was no sign of the aerating cortex so commonly found in the various species of *Salicornia*. The material however consisted only of shoots cut off from the bush, so that the bases of the stems were not represented.

The Leaf.

In the disposition of the leaf-tips, the free foliar sheath and the adnate foliar region, *H. strobilaceum* bears a closer general resemblance to *Salicornia glauca* than to any other member of the genus, but the segments are even shorter than in this species. The general structure of the leaf-tip and sheath are such as has been described for the Salicornieæ, so that only the features characteristic of *Halocnemum* will be detailed here.

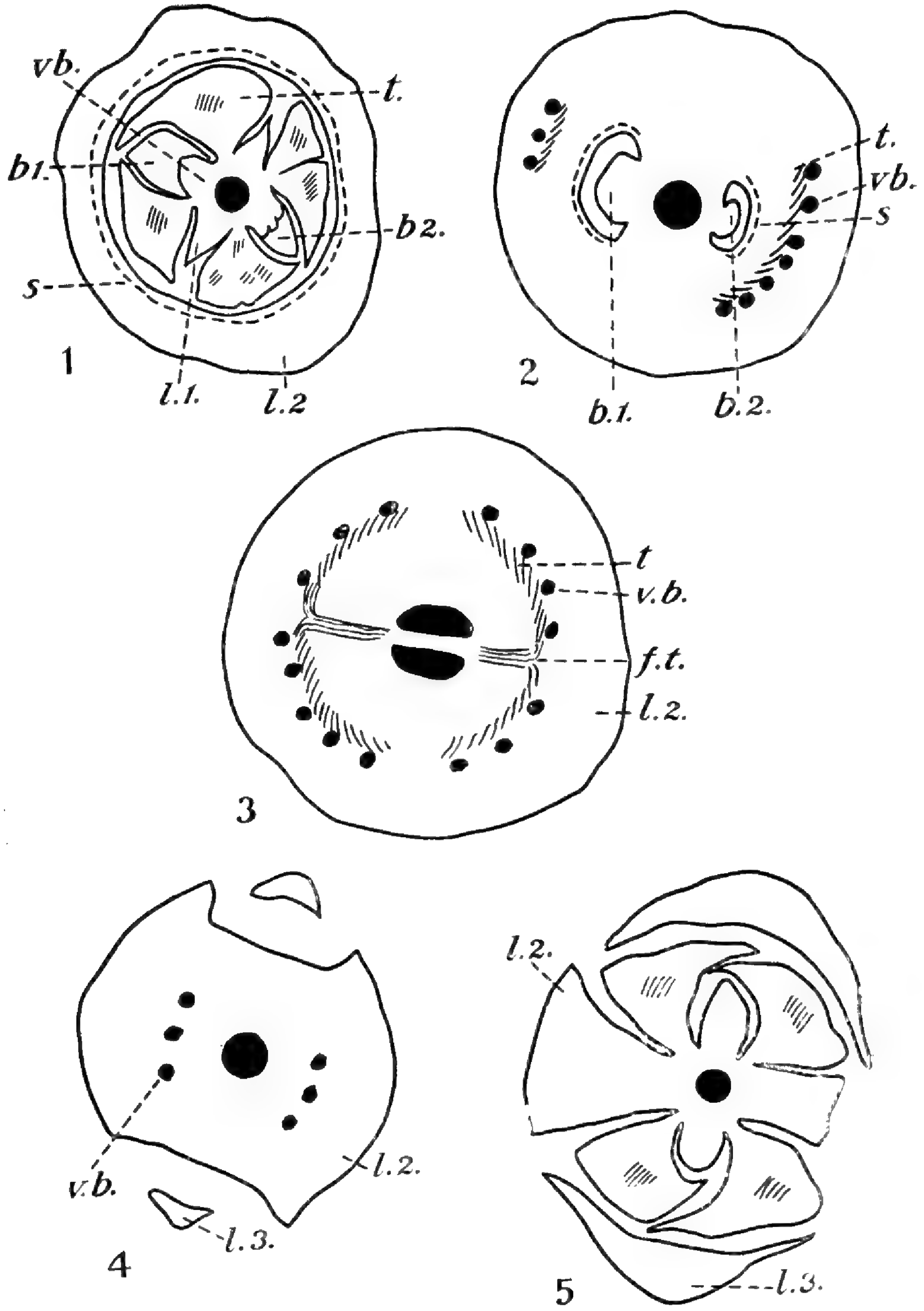
At the node one vascular strand passes out to each leaf, this foliar trace branches into three during its passage through the aqueous tissue of the sheath, and the two lateral branches curve gradually round the sheath just below the palisade tissue (*f.t.*, text-fig. 12, **3**). Transfusion tracheids (*t.*) develop in abundance in the plane at right angles to that of the exit of the two foliar traces. The two lateral branches derived from each leaf-trace branch repeatedly and curve downwards into the basal adnate sheath region, and the xylems of the small bundles thus produced are connected by the abundant transfusion tracheids. Towards the base of the internode these transfusion elements die out, the bundles of the foliar vascular system rapidly diminish in number, they become restricted to the plane of the leaf-trace exit (*v.b.*, text-fig. 12, **4**), and, finally, they end blindly in the aqueous tissue. In this part of the leaf there is an absence of both the spiral and spicular cells found in a similar region in the various species of *Salicornia.* The median bundle of the foliar trace passes steeply upwards, and numerous transfusion tracheids develop on its ventral surface. This central strand branches and forms several small bundles, the xylem in each being connected with that of its neighbour by the transfusion elements (*vb.* and *t.*, text-fig. 12, **2**). Both bundles and tracheids finally end blindly in the aqueous tissue, before the sheath separates into its two free tips. In the leaf stereides occur abundantly in the position marked by the dotted line *s*, in **1** and **2** of text-fig. 12. Their long axes coincide with the long axis of the member in which they occur, and they are usually placed in a single layer immediately under the epidermis. Their unbranched nature and their usually larger size distinguish them from the similar elements which are characteristic of *S. glauca.*

In text-fig. 12 (p. 342) the influence of the development of the rosette buds on the foliar sheath is shown.

Fig. **1**, which represents a transverse section a short distance above the node, shows two buds (*b. 1* and *b. 2*) whose growth has so encroached upon the adnate leaf-sheath of the pair of leaves of the node above, that the latter appears in the form of two wedge-like masses of tissue situated on opposite sides of the stem (*l. 1*). This is exactly comparable to what occurs in the case of the flowering segments of *Salicornia*, where the growth of the pair of flower-cymes similarly affects the bract-sheath (*cf.* text-fig. 5). The stem, with its two decurrent foliar wings alternating with the rosette-buds, is at this level entirely surrounded by the free foliar sheath of the pair of leaves (*l. 2*) belonging to the node below. In **2**, this foliar sheath (*l. 2*) has almost entirely fused with the stem, the extreme basal region of the two buds (*b. 1* and *b. 2*) is, however, still marked. Soon after the node is passed (text-fig. 12, **3**), preparation for the pair of buds of the node next below is seen, in the flattening of the foliar sheath (*l. 2* in text-fig. 12, **4**), and successive sections passing down the internode towards its base, show the complete hollowing out of the tissue and the reduction of the sheath to two wing-like plates (text-fig. 12, **5**). Shortly below the level represented in **5** the free-leaf tips (*l. 3*) fuse laterally, forming a sheath round the stem, just as is shown in **1**.

Text-fig. 13 (p. 343) shows a rosette-bud from an older shoot than the one just described. Anatomically the leaves of the bud are identical in structure

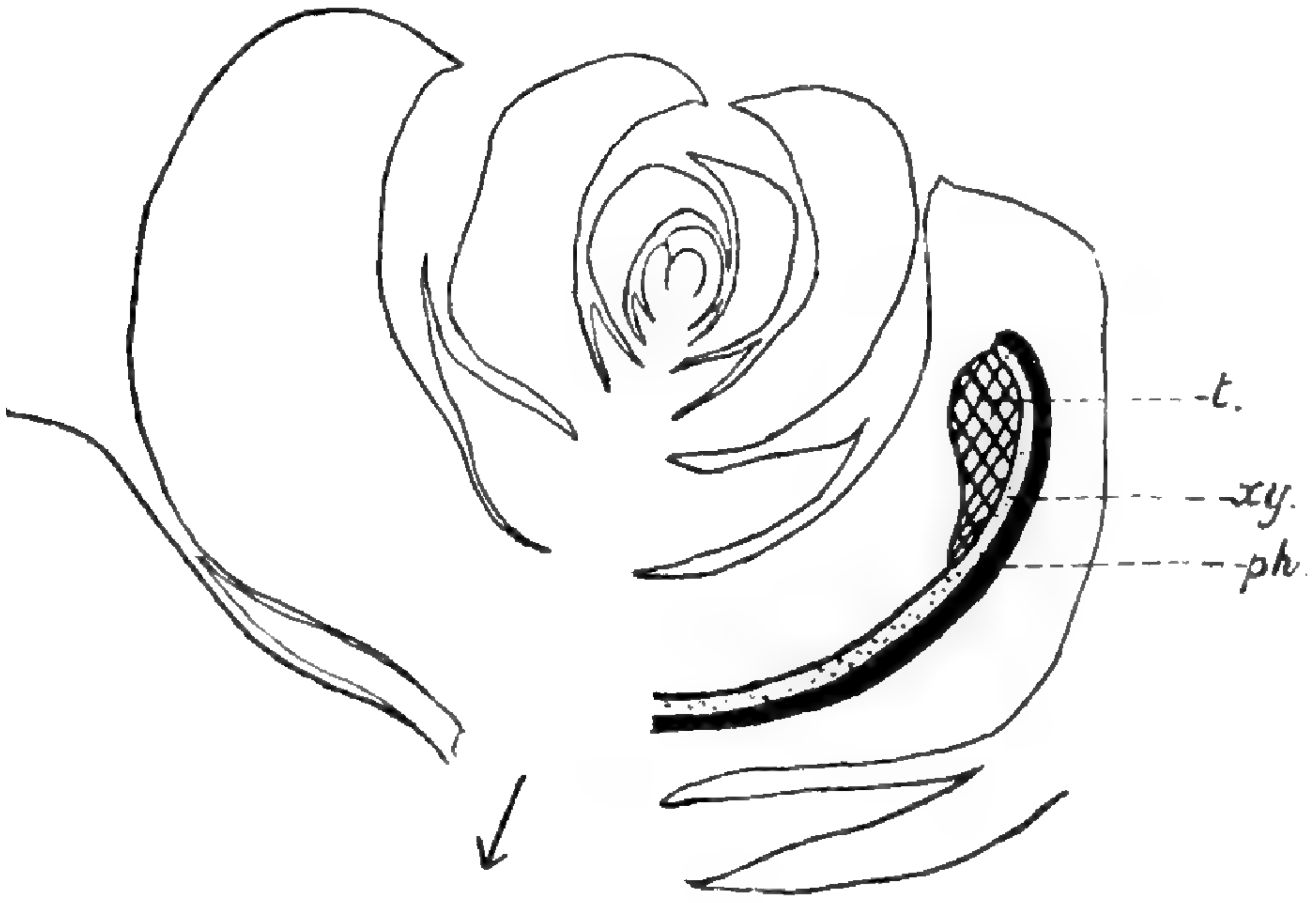
Fig. 12.



Halocnemum strobilaceum, Bieb.

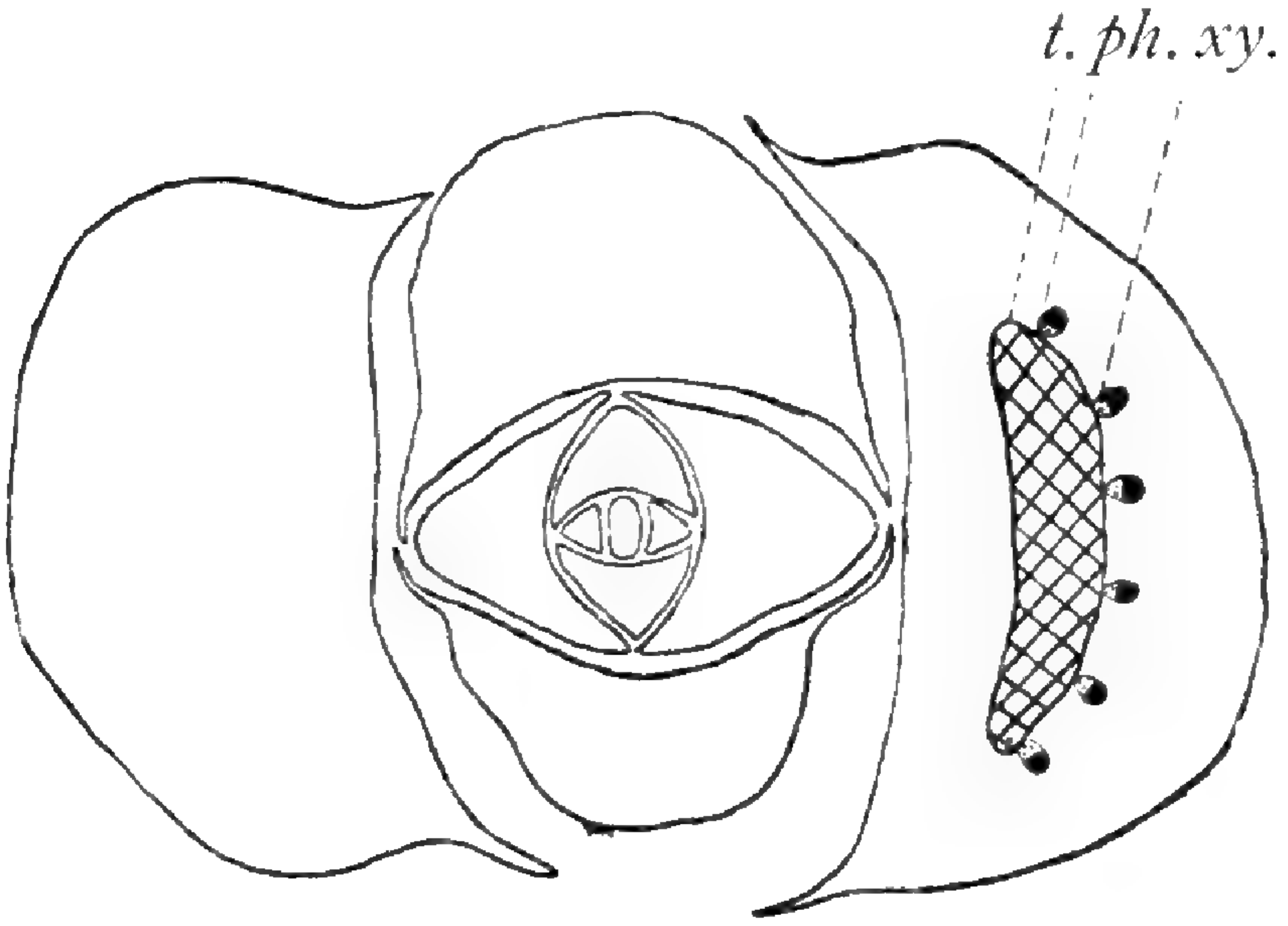
with the free leaf-sheath such as is shown in text-fig. 12, **4.** A single vascular strand enters each leaf from the bud-axis, it branches towards the middle of the leaf in a fan-like manner, and the bundles thus formed enclose on the ventral surface a nest of transfusion tracheids (*t.* in text-fig. 13).

FIG. 13.



Longitudinal section through a rosette of *Halocnemum strobilaceum*, Bieb. Vascular tissue omitted except in one leaf. *t.* = transfusion tracheids; *xy.* = xylem; *ph.* = phloem.

FIG. 14.



Halocnemum strobilaceum, Bieb. Transverse section of a rosette. The vascular tissue is omitted except in one leaf.
t. = transfusion tracheids; *xy.* = xylem; *ph.* = phloem.

This is more clearly shown in the transverse section of the leaf given in text-fig. 14.

The tracheids and then the bundles end blindly in the aqueous tissue some distance below the apex of the leaf. Long stereides frequently occur below the epidermis on the ventral surface of the leaf, the long axis parallel with that of the leaf.

Material for the investigation of the root and of the flowering shoot was unfortunately not available for examination.

I should like to take this opportunity of thanking Professor F. W. Oliver, at whose suggestion this work was begun in the Field Laboratory at the Bouche d'Erquy, in Brittany, and in whose laboratory at University College, London, it was completed.

A great part of the investigation was carried out at the University of London, Goldsmiths' College, and many thanks are due to Mr. T. G. Hill for his help and advice during its progress.

We regret that the work of some investigators of the Salicornieæ has had to be ignored. Some of the binomials which have been used are so vague that, until every single genus has been studied in detail and correlated with their work, it is impossible to ascertain which species they used in their investigation.

SUMMARY.

1. The succulent "cortex" which covers the internodes of a Salicornian shoot is foliar in origin, and is phylogenetically derived from the basally developed leaf-sheath of the pair of leaves of the node above. This conclusion is based upon the evidence afforded by:—

(*a*) The development of the shoot behind the apex.
(*b*) The anatomy, and the course of the vascular bundles.
(*c*) The structure of the flowering shoot.
(*d*) The leaf-fall.
(*e*) The morphology of the seedling.
(*f*) The morphology of species of allied genera.

2. The anatomy of the leaf is similar to that of any other succulent dicotyledon. It has a two-layered palisade parenchyma and well developed aqueous tissue. Numerous vascular bundles lie between the palisade layer and the water-storing tissue. The development of cuticle is slight, except in *S. glauca* and *S. fruticosa*. The structure of the free leaf-tips, the tubular leaf-sheath, and internodal sheath is practically identical.

3. Each foliar trace divides into three on passing out from the stem at the node. The median strand branches, and forms the vascular system of the free leaf-tip, the two lateral strands curve outwards and downwards and by their repeated branching form the so-called "cortical" bundles of the internodal sheath.

4. The flowering spike is constructed on the same plan as the vegetative shoot, but the internodal bract-sheath is necessarily modified on account of the two groups of flowers which develop at the node.

5. Leaf-fall occurs in both the annual and perennial species. It is due to the suberisation of the cells of the outer layers of the stem tissues, beginning in the endodermis and extending inwards, this results in the death of the internodal foliar tissue and its subsequent separation at the limit between the stem and leaf.

6. The seedling has two small, fleshy cotyledons and a short thick hypocotyl. The cotyledons fuse and form a cotyledonary sheath to the hypocotyl similar to the leaf-sheath of the vegetative shoot. The hypocotylar sheath has an outer series of bundles derived from the two cotyledonary traces.

Transition from stem to root structure takes place high up in the hypocotyl and follows Van Tieghem's Type III.

7. The morphology of *Kalidium foliatum* and *Halocnemum strobilaceum* further indicates how the Salicornian condition may have arisen.

8. The discovery of every form of transitional element between spiral cells and stereides leads to the conclusion that the two are homologous structures ; the former function chiefly in water storage, the latter in mechanical support.

9. Anomalous secondary growth sets in early in both root and stem. A secondary, pericyclic cambium gives rise on its inner margin to a thick zone of lignified intermediate tissue, in which concentric series of collateral vascular bundles are embedded.

10. At the base of the main stem, the upper part of the main root, and the rhizome of the perennial species, the secondary cambium forms an aerating cortex of greater or less extent. In *Salicornia herbacea* it develops into a thick coating of aerenchyma, and ribs of this tissue occur in *S. ramosissima*.

11. *Halocnemum strobilaceum* has long and short shoots. The long shoots are covered with decussately arranged, fleshy leaf-buds, which latter develop into the short shoots. The long shoots are old "short shoots" from which the foliar sheath has fallen leaving the buds exposed. The jointed segments of the short shoots are similar to those of *Salicornia*. The anatomy of the free leaves of the bud and the foliar sheath of the segment is essentially similar, and agrees in all important points with that of *Salicornia glauca*, but stereides are absent from the palisade parenchyma, and the foliar bundles of both the free leaves and the sheath are associated with numerous transfusion tracheids.

May 17*th*, 1913.—Since the above paper was written a publication * has appeared on the plant-habits and structure of *Salicornia australis*; as the interpretation of certain anatomical features differs from that given in the present investigation, it seemed desirable to add the following notes.

The author states very briefly various considerations which have led to the conclusion that "it is the greatly developed leaf-base which forms the 'cortex' referred to by writers on *Salicornia*." Details are given as to the stomata, the aqueous tissue, the palisade layer, the apical growth, and the seedling of the species.

The occurrence of spiral cells in the palisade tissue of the leaf and leaf-base is recorded, but their function is ascribed to air storage (*cf.* p. 333).

A full account is given of the mode of secondary growth of the stem and root. A pericyclic extrafascicular cambium ring forms centripetally, xylem consisting of "thick-walled fibrous cells, among which are situated, in irregular rings, the vessels, with very large lumens." Scattered among the fibrous cells of the xylem and lying just outside the large vessels are phloem islands. The extrafascicular cambium forms phloem centrifugally, this bast consisted of parenchyma like cells with chlorophyll and starch grains, but no sieve tubes were present; some of the cells of the phloem disintegrate, "those remaining being arranged in radial rows, between which are large intercellular spaces."

The secondary thickening of the stem and root of the species of *Salicornia* examined during the present investigation differs essentially from the above account; the extrafascicular cambium is regarded as giving rise centripetally to collateral bundles of wood and bast embedded in fibrous "intermediate tissue," centrifugally a zone of aerating cortex variable in extent is produced (*cf.* p. 337 *seq.*).

The paper concludes with a description of the flowers and fruit. The point of greatest interest in this connection lies in the fact that five to ten flowers occur in each leaf axil, while occasionally as many as sixteen may be found, a double row round the stem then being produced.

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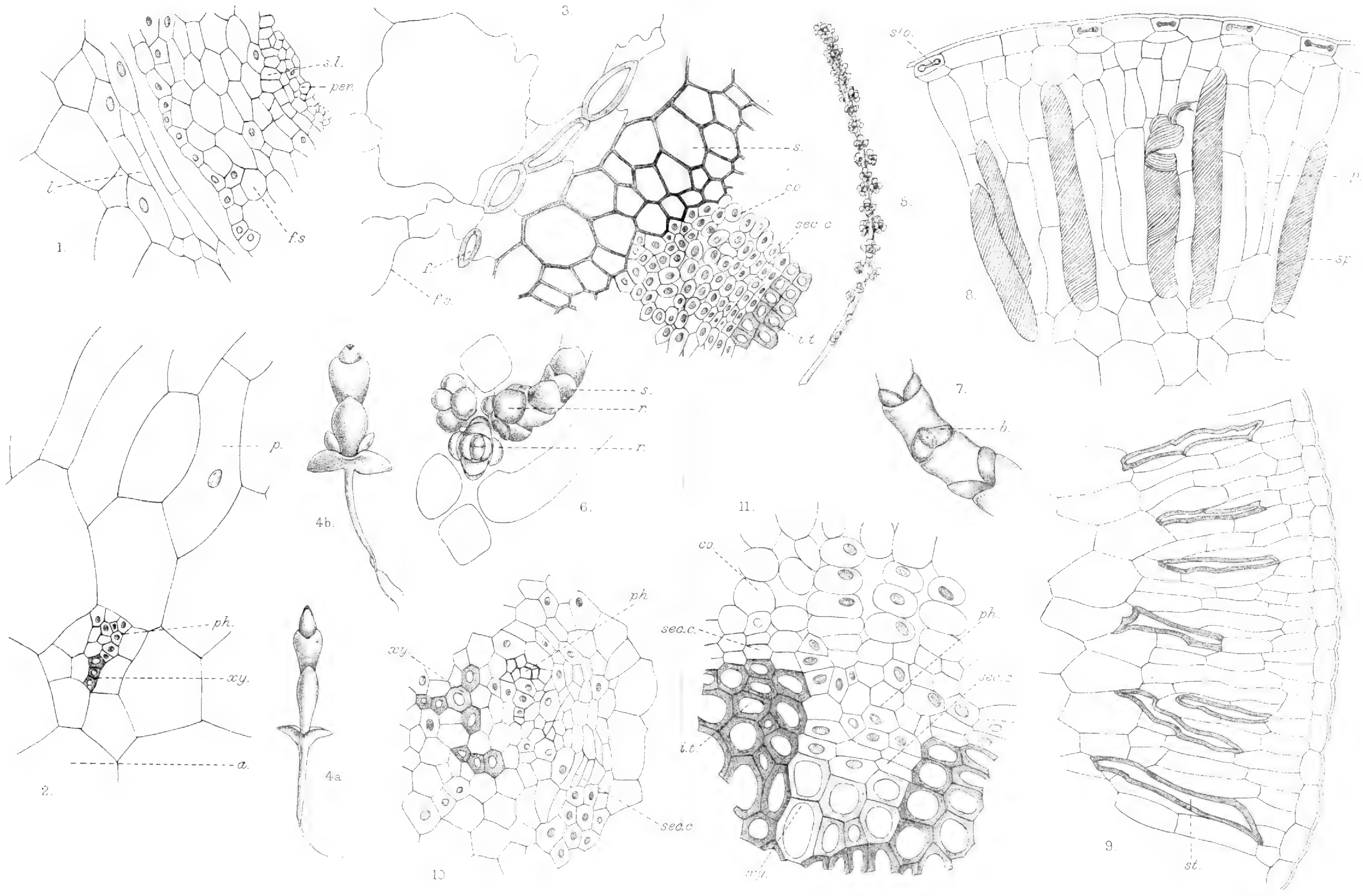
* Cooke, F. W., *loc. cit.* p. 349.

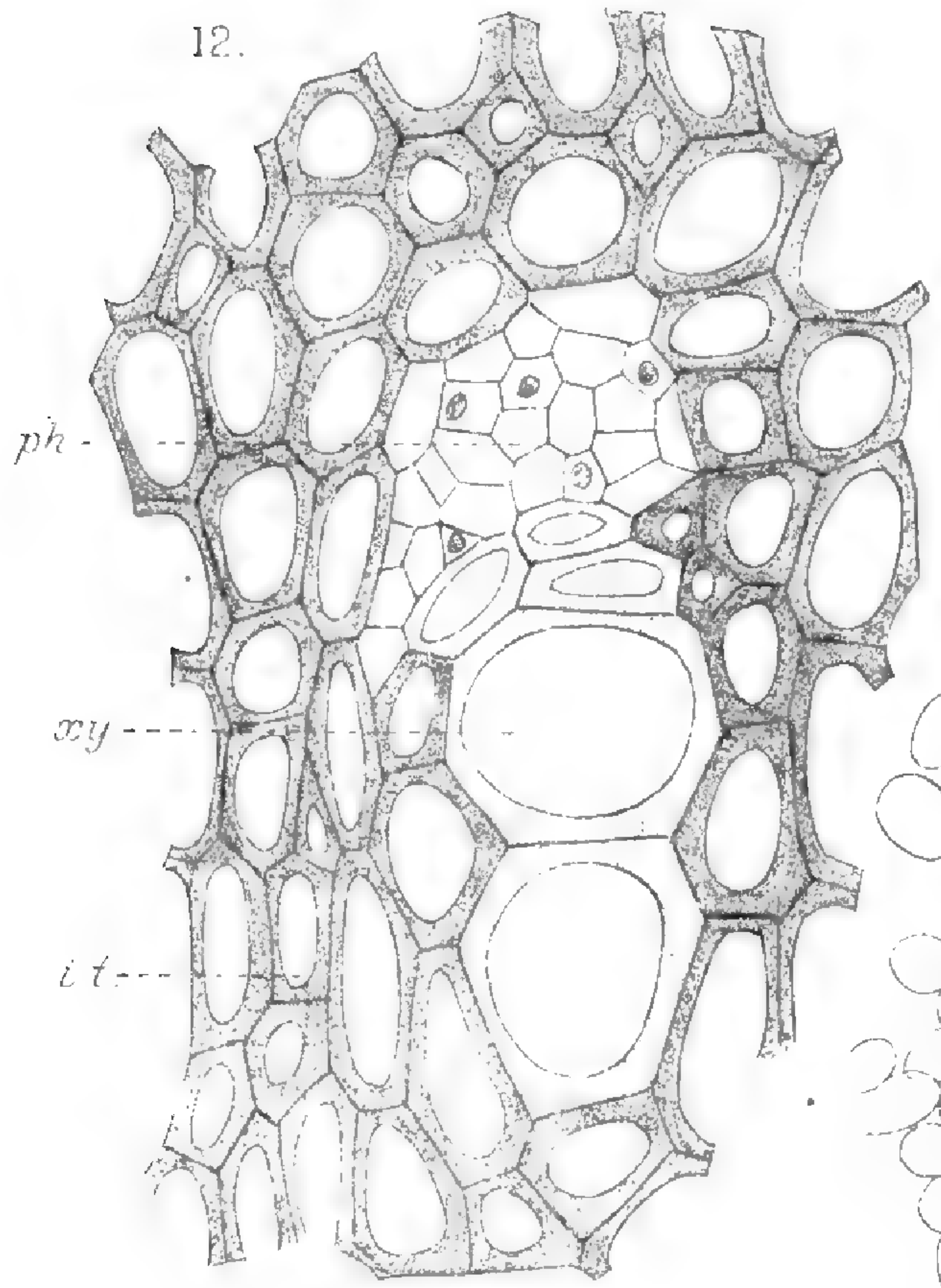


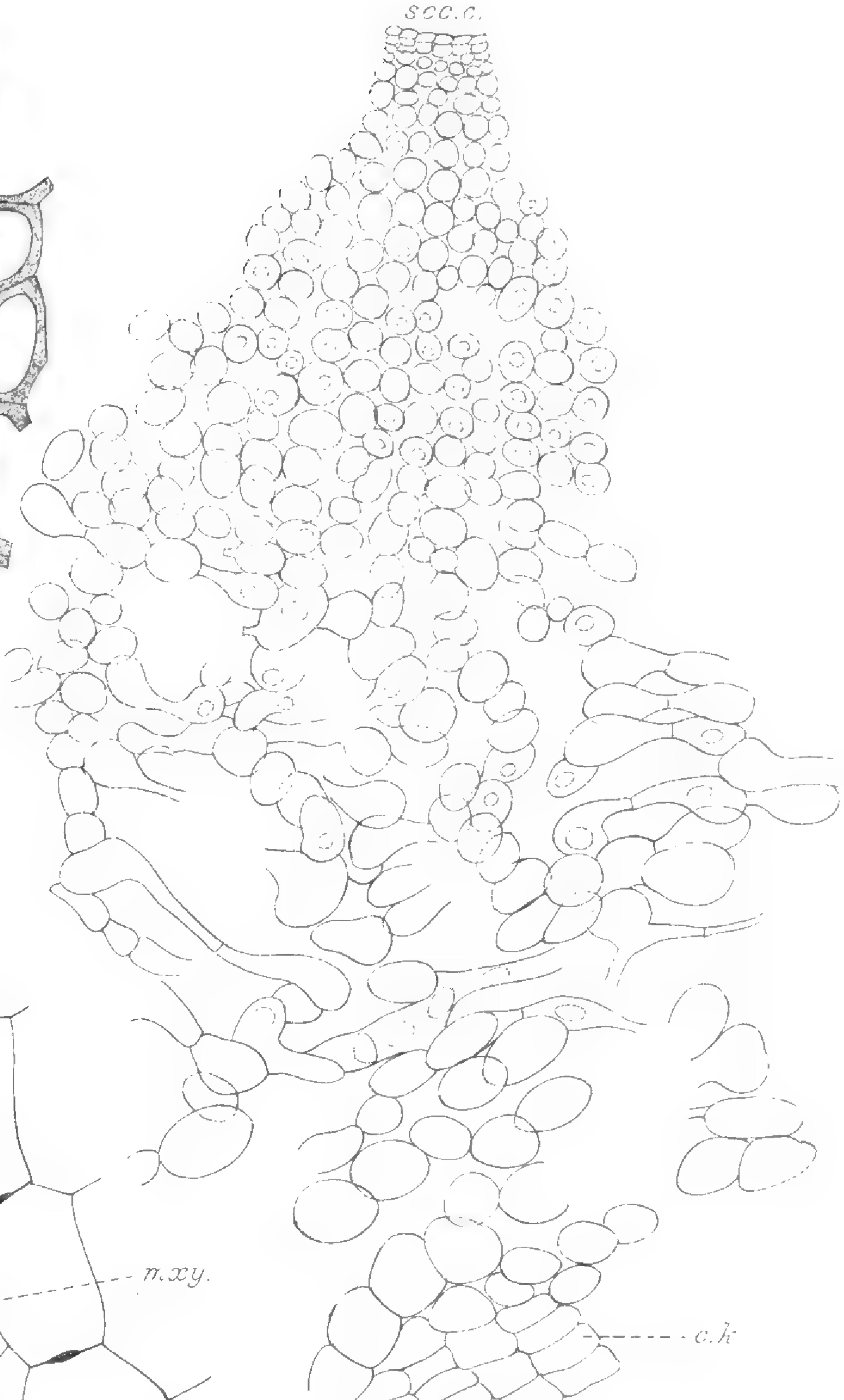
E. de F. del.
J.N.Fitch lith

West, Newman imp.

ANATOMY OF SALICORNIA.

12.





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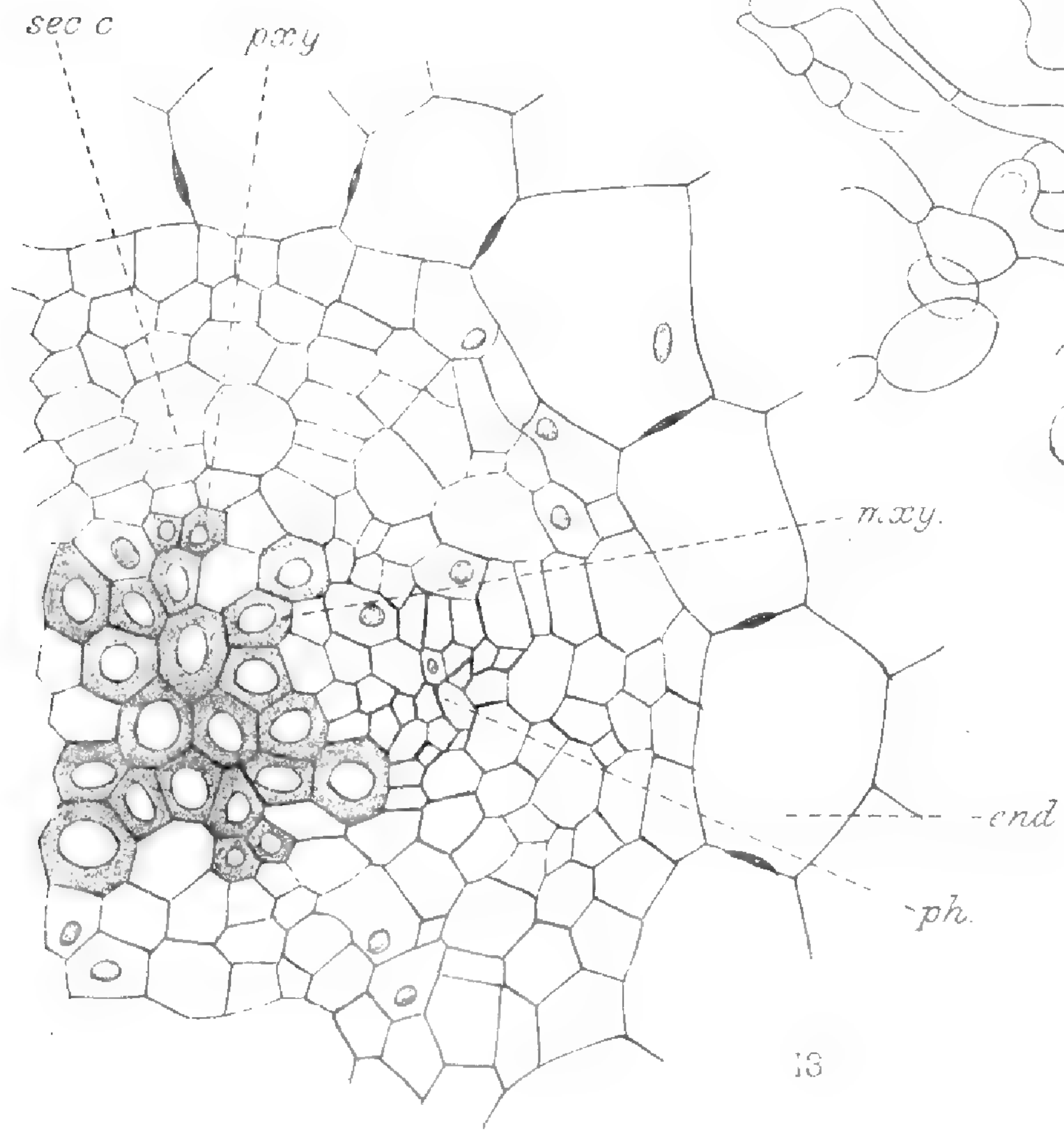

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E. de F. del.
J N. Fitch lith.

West, Newman imp.

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EXPLANATION OF THE PLATES.

Abbreviations used:—*xy.* = xylem; *m.xy.* = metaxylem; *p.xy.* = protoxylem; *ph.* = phloem; *sec.c.* = secondary cambium; *per.* = pericycle; *end.* = endodermis; *p.* = palisade tissue; *a* = aqueous tissue; *aer.* = aerenchyma; *a.c.* = aerating cortex; *c.k.* = cork; *st.* = stereides; *sp.* = spiral cells; *i.t.* = intermediate tissue; *f.* = fibrous cells: *sto.* = stoma; *sl.* = suberised layer; *l.* = free leaf-sheath; *f.s.* = foliar sheath; *c.o.* = secondary cortex; *b.* = "rosette" bud; *r* = "rosette"; *s.* = short shoot; T.S. = transverse section.

PLATE 15.

Fig. 1. *S. perennis*, Mill. T.S. of stem immediately above a node; fusion between the leaf-sheath *l* and the "adnate" sheath *f.s.* takes place just below this level. *s.l.* = endodermis. × 520.

Fig. 2. *S. perennis*, Mill. T.S. of a bundle of the foliar sheath showing the normal histological orientation. × 520.

Fig. 3. *S. perennis*, Mill. T.S. of a segment showing the suberised stem layers covered with the collapsed foliar sheath. × 290.

Fig. 4. (*a*) Seedling of *S. perennis*, Mill. × 2.
(*b*) Seedling of *S. prostrata* var. *Smithiana*, Moss. × 2.

Fig. 5. *Halocnemum strobilaceum*, Bieb. Long shoot covered with decussately arranged "rosettes." Nat. size.

Fig. 6. *H. strobilaceum* Bieb. Short shoot arising from a "rosette." Much enlarged.

Fig. 7. *Halocnemum strobilaceum*, Bieb. Part of a short shoot showing the arrangement of the rosette buds. Much enlarged.

Fig. 8. *Salicornia fruticosa*, Linn. T.S. of the foliar sheath showing spiral cells. ×112.

Fig. 9. *S. glauca*, Del. T.S. of the foliar sheath showing stereides. ×112.

Fig. 10. *S. perennis*, Mill. T.S. of stem showing the secondary cambium arc immediately outside the primary bundle. ×520.

Fig. 11. *S. perennis*, Mill. T.S. of stem showing the method of formation of one of the anomalous collateral bundles. ×520.

PLATE **16.**

Fig. 12. *S. perennis*, Mill. T.S. of stem showing the collateral bundle embedded in lignified intermediate tissue. ×520.

Fig. 13. *S. prostrata* var. *Smithiana*, Moss. T.S. of the central part of a young root, showing the beginning of the secondary cambium. ×520

Fig. 14. *S. herbacea*, Linn. T.S. of stem showing the aerenchyma. ×112.

On Branching Specimens of *Lyginodendron oldhamium*, Will.

By WINIFRED E. BRENCHLEY, D.Sc., F.L.S. (University College, London).

(With 5 Text-figures.)

[Read 1st May, 1913.]

THE following notes on the branching of *Lyginodendron* were made about six years ago, but publication was delayed in the hope that it would be possible to work out various other problems, such as the bud-structure of the plant. This has not been practicable, so it seems advisable at the present juncture to publish this brief note on the branching just as it stands, without further delay. No attempt has been made to bring this account into line with recent developments, but Miss Winifred Smith, B.Sc., has now taken over the material with the intention of working out the other items of interest for a later paper, so as to bring the work up to date.

Lyginodendron oldhamium, which is one of the best known of Palæozoic fossil plants as regards its anatomical structure, owes its position in this respect largely to the great wealth of material available, usually in a well preserved condition, which has enabled investigations to be carried out, chiefly by Williamson and Scott[*]. Yet, in spite of the very numerous specimens which had been examined, especially since the appearance of Williamson's first memoir on the plant in 1873, no stem of *Lyginodendron* had been known to branch until comparatively recently. As late as 1900 Scott[†] remarked: "No stem of *Lyginodendron* has ever been observed to branch. It does not follow that it never did so, but certainly branching must have been very rare." Some years ago, however, evidence of ramification came to light. At the British Association in 1902, Lomax[‡] briefly described two specimens of branching *Lyginodendron* stems from Dulesgate, one three, the other four inches long. One of these is excellently preserved and runs through two internodes, roots as well as branches passing off. Since then two more good examples have been found at Sharney Ford, near Bacup; one, now in the University College Collection, possessing six nodes, the other, originally in the possession of Dr. Scott, showing five. Both these Sharney

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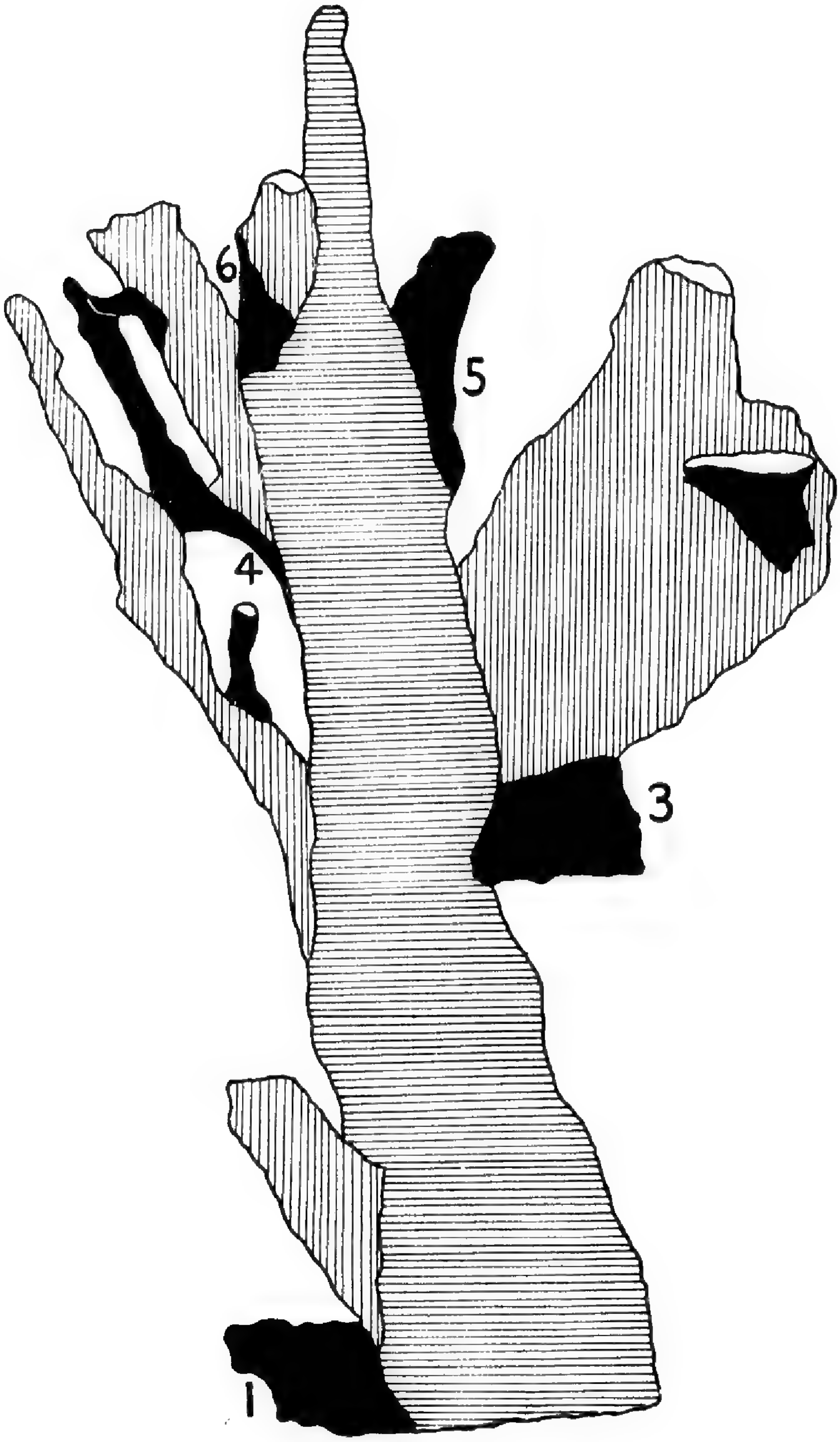
[*] Williamson, W. C.: "Organisation of Fossil Plants of the Coal-Measures," Phil. Trans. Roy. Soc. 1873, pp. 377–408; *ibid.*, 1890 B, pp. 89–106. Williamson W. C. & Scott, D. H.: "Further Observations on Organisation," Phil. Trans. Roy. Soc. 1895 B, pp. 703–779.

[†] Scott, D. H.: Studies in Fossil Botany, 1st edition, 1900, p. 321.

[‡] Lomax, J.: "On some new features in relation to *Lyginodendron oldhamium*," British Association Report, Belfast, 1902; Ann. of Bot. xvi. p. 601. See also Scott, 'Studies,' 2nd edition, 1909, p. 371, fig. 137.

Fig. 1.



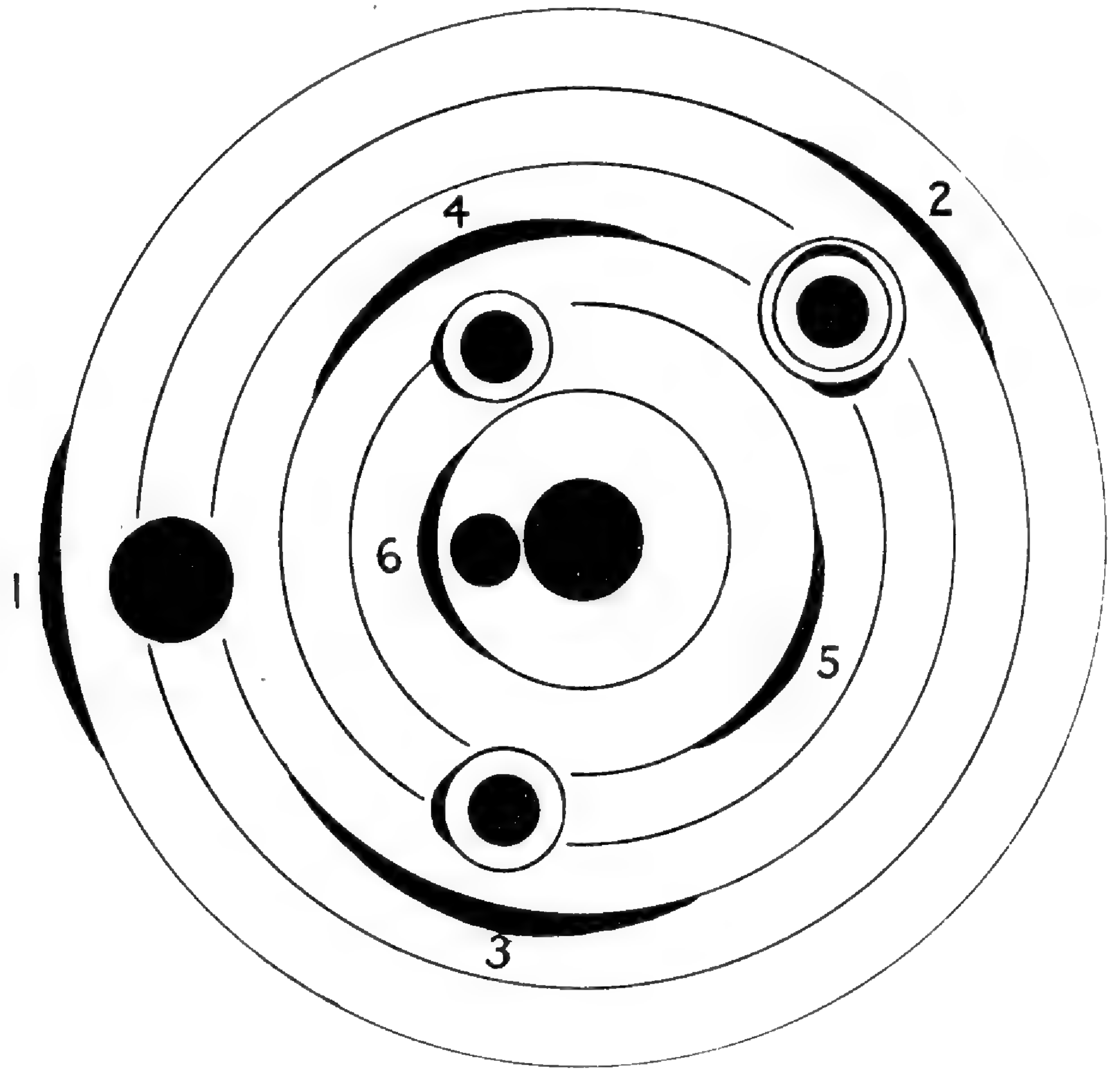
Elevation of model of University College specimen. Three-quarters natural size.

Horizontal shading = main axis; vertical shading = primary branches; black = leaf-bases.

Ford specimens were ultimately investigated, and are described in the present paper.

The original block of the University College specimen was 4¾ inches long, and had been cut to form a series of thirty-eight slides, thus averaging one section to every ⅛ inch length of the specimen. The outline of each section of the stem with its attendant branches and petioles was traced by placing the slide, covered with tracing-paper, against a window. This was, perhaps, the most ticklish part of the whole process, because it was often not easy to be certain whether a particular branch or petiole belonged to the specimen under consideration or not. The difficulty was increased by the fact that sometimes, owing to bad preservation, a particular part would disappear from one or more slides only to reappear later on in the series, when it was not

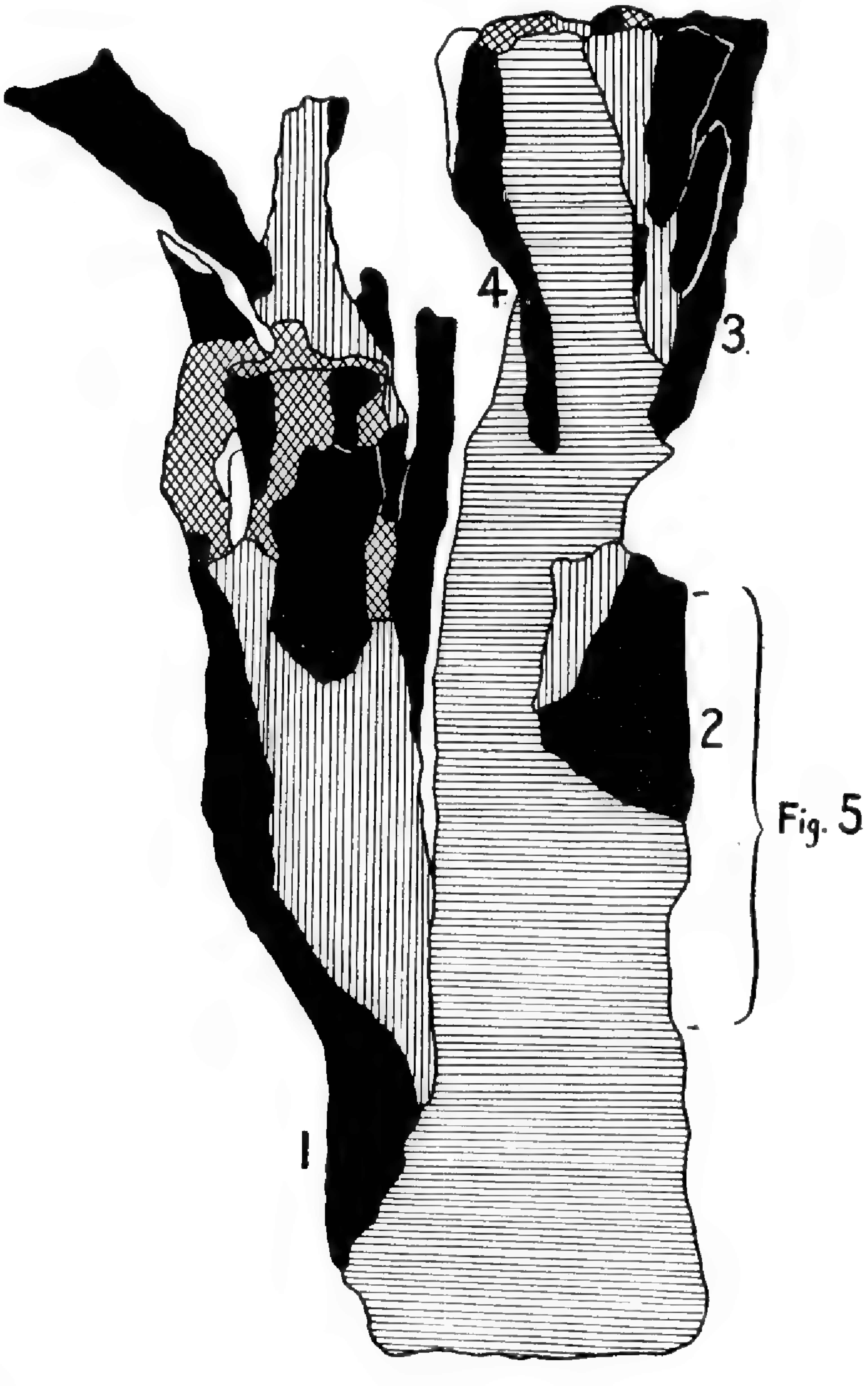
Fig. 2.



Ground-plan of University College specimen; constructed from the model.
Six leaves are borne by the main axis—five of these subtending axillary branches.
None of the branches show further ramification.

easy to trace the connection. It was decided to make the model as nearly as possible twice the size of the original. Since each section represented $\frac{1}{8}$ inch length of the actual stem, slabs of paraffin-wax were cast to the exact thickness of $\frac{1}{4}$ inch. This wax was of such a consistency that in the hot

Fig. 3.

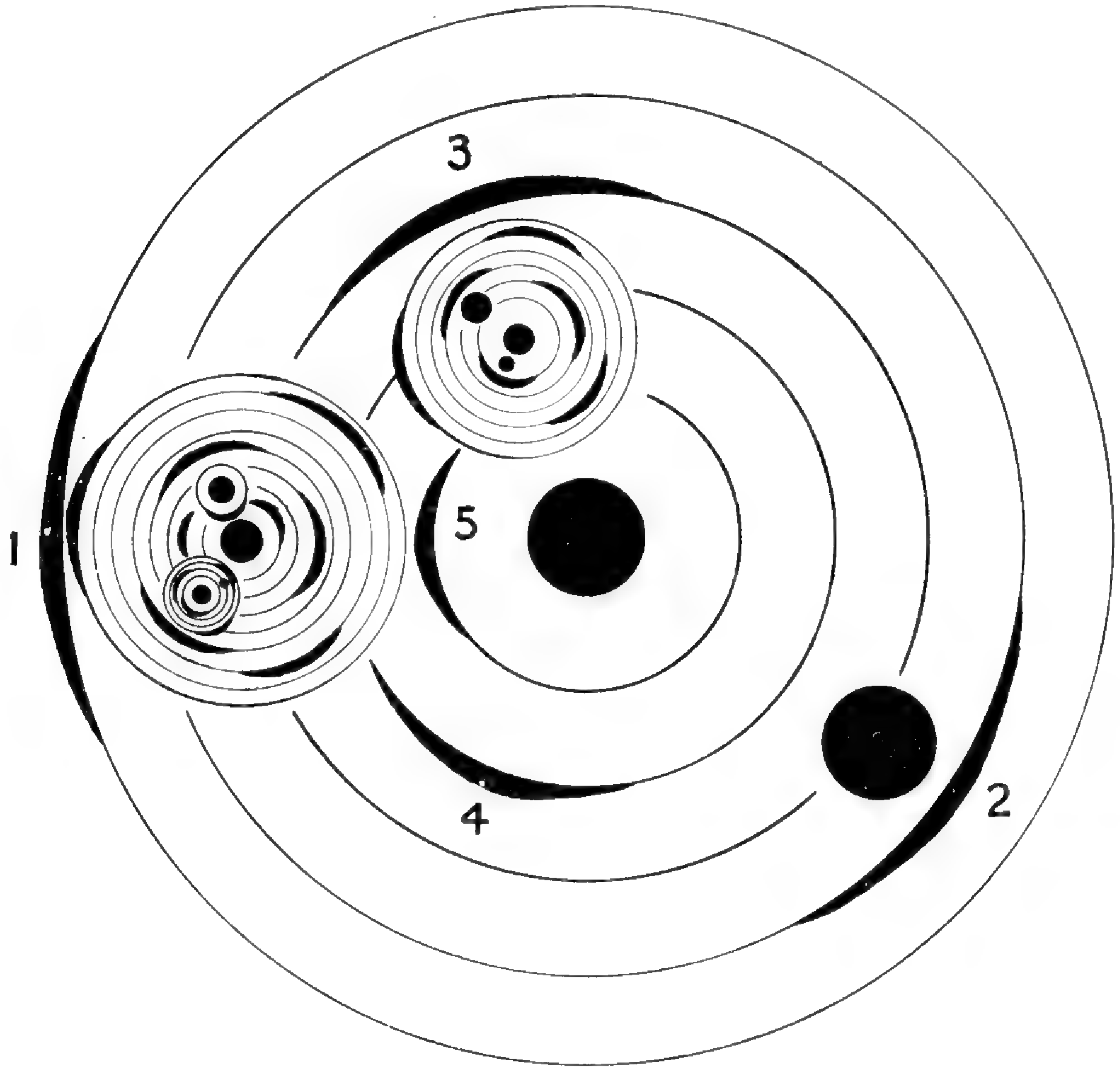


Elevation of model of Dr. Scott's specimen. Three-quarters natural size.

Horizontal shading = main axis; vertical shading = primary branches; cross hatching = secondary branches; black = leaf-bases.

summer weather it cut like very stiff cheese, but in the cold winter months it was necessary to warm it over a stove to prevent it from shattering when cut. By means of a pantagraph, in which the pencil was replaced by a sharp-pointed stylo, the outlines obtained by tracing were enlarged to two diameters directly on to the wax. These outlines were cut out and carefully numbered. The model was then built up by comparing one slide with the next, arranging the pieces of wax in their appropriate positions with regard to one another and to the previous sections. When absolutely in place the edges were melted together. A good deal of trouble was experienced at this stage because the wax kept breaking apart at unexpected places between the sections. When complete, hot copper wires were thrust in to bind the whole together and to give it stability. In modelling Dr. Scott's specimen this difficulty was

FIG. 4.



Ground-plan of Dr. Scott's specimen; constructed from the model.

The main axis bears five leaves, of which three subtend branches. Two of the branches show further ramification.

overcome by pushing in short pins at every three sections, which made the structure very much stronger. The resulting rough step-like model was smoothed down with hot copper wire and polished off with modelling tools. To distinguish the different parts, the main stem was painted black, the branches brown, and the leaf-bases and petioles green. In the case of Dr. Scott's specimen the exact length of the original was not known, so it was assumed that approximately the same amount of wastage would occur in cutting the sections, and the model was constructed on the assumption that each section represented $\frac{1}{8}$ inch length of the original stem, the enlargement being again two diameters.

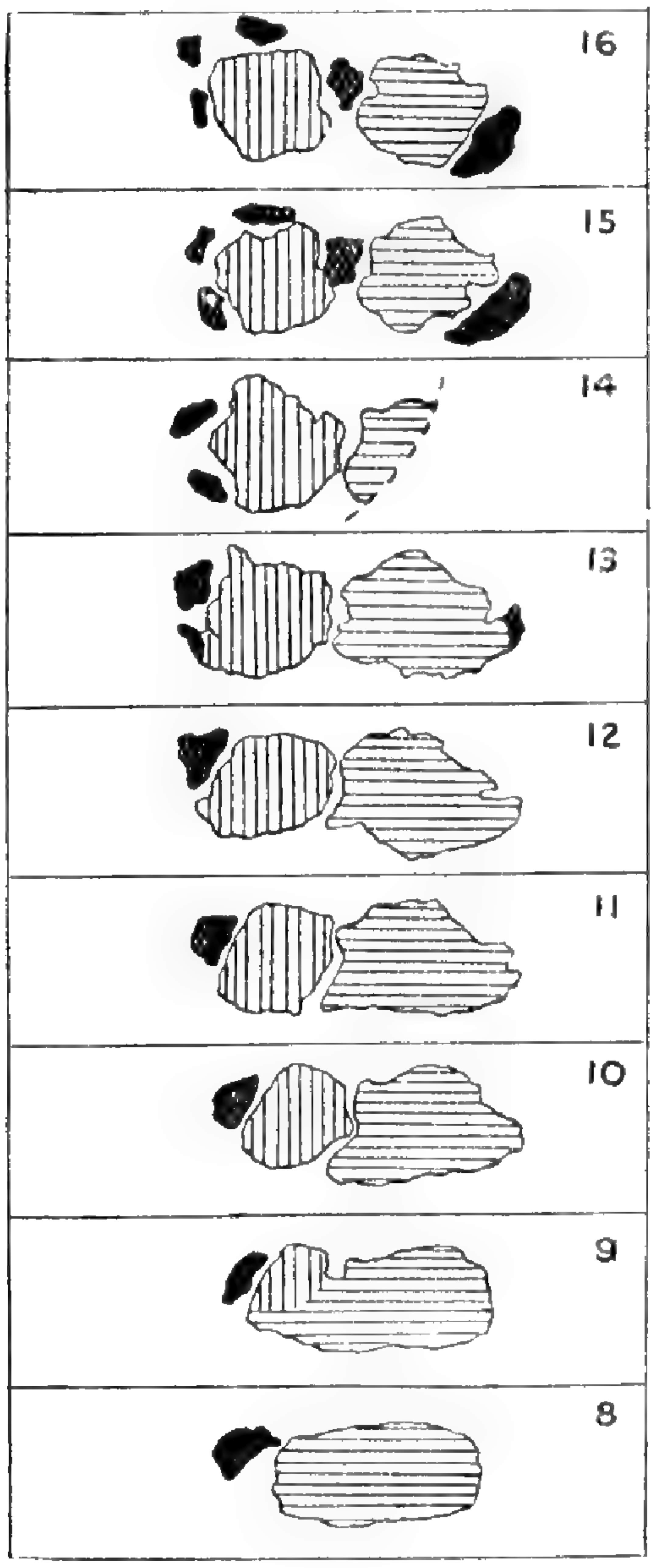
The University College specimen (fig. 1, p. 352) shows six leaf-bases (1–6), and branches spring from the axils of five of them. Some of these in their turn bear leaf-bases, but no secondary ramification occurs. The branch in the axil of leaf-base no. 3 is most exceptionally large, being bigger than the main stem at the base, and continuing so all the way along. Dr. Scott's specimen (fig. 3), though a little smaller, is much more complex. As before, every branch is axillary. The main stem shows a primary branch from the lower three of its five nodes. Two of these primary branches exhibit secondary ramification, and one of these secondary axes again divides, so that, in addition to the principal axis, there are branches of the first, second and third orders, axillary in every case. It seems most probable that the origin of both these specimens was near the top of the plant, as the diameter of the main axis decreases markedly from base to apex, and moreover the leaf-bases are very much crowded together at the summit. The tissues of the petioles and the branches are fully developed and do not seem at all embryonic in structure, thus indicating either that the sections are cut some little way below the actual apex of the stem, or that the specimens had exhausted their growth.

One point in connection with the phyllotaxis is noticeable—the direction of the spiral formed by the leaf-bases on an appendage is always the reverse of that on the axis on which it occurs, *i.e.* when the spiral on the main axis is counter-clockwise in direction that on the primary branch is clockwise, and that on the secondary appendage counter-clockwise again (*cf.* ground-plans of models, figs. 2 & 4). This arrangement was so strikingly evident that a number of living trees and shrubs were examined to see if a similar phenomenon occurred in modern plants, but in no single instance that came under observation could any regularity be observed. It would be interesting to obtain more definite information on this point. The idea suggests itself that this was a regular characteristic of *Lyginodendron*, but this naturally cannot be settled until additional specimens of branching stems are available for examination.

The branching of the main axis seems to disturb the phyllotaxis considerably. That of the main axes themselves is consistently the normal $\frac{2}{5}$

with one slight exception where the petiole fails to come off, but in the branches this divergence is lost. It is unusual to find more than five distinct leaf-traces in the pericycle of *Lyginodendron* *, but a primary branch in Dr. Scott's specimen shows six, the phyllotaxis being in two separate sets of $\frac{2}{6}$ (not $\frac{1}{3}$), while a secondary appendage in the same specimen attains the number of seven, where the divergence is possibly $\frac{2}{7}$. The branches in the specimens overlap one another to some extent, so that it is quite usual to find two branches in different stages of formation at the same level. This probably has a good deal to do with the considerable disturbance of phyllotaxis.

FIG. 5.



Tracings of outlines of nine successive sections of Dr. Scott's specimen, as shown by brackets on text-fig. 4.

Horizontal shading = main axis; vertical shading = primary branch; black = leaf-bases. All reduced to three-fourths natural size.

Unfortunately the preservation of both the specimens is too poor to allow of any detailed investigation of the behaviour of the vascular structures when a branch is given off. The secondary wood of the stem begins to swell below the point of exit of the branch. This swelling increases, so that usually quite a large bulk of secondary tissue is ready to pass out. Gradually separation of the two masses of wood takes place, and both parts close up and are rounded off. It is noticeable that there is frequently, if not usually, a good deal of secondary wood in the pith when a branch is being given off, and it seems possible that the anomalous tissue may help to close up the gap formed by the mass of xylem passing off to supply the shoot.

A good deal of diversity exists in the manner in which the xylem of the branch behaves with regard to the petiole in whose axil it is, as in some cases the petiole and branch pass off quite independently, while in others they remain attached to one another until they have jointly separated from the stem, not parting company until a later stage.

---

* Williamson, W. C., & Scott, D. H.: Phil. Trans. Roy. Soc. 1895 B, p. 709.

Owing to bad preservation at the critical points it was impossible, in either of these specimens, to examine the primary bundle-system of the axillary shoots in relation to that of the stem.

SUMMARY.

(1) Stems of *Lyginodendron* occasionally branch, and in each case observed the branching is axillary.

(2) Primary, secondary, and tertiary ramification occurs in one of the two specimens investigated.

(3) In the two specimens examined the direction of the phyllotaxis spiral of a branch is always the reverse of that of the axis on which it occurs.

(4) The giving-off of branches from an axis seems to disturb the phyllotaxis considerably, the normal divergence of $\frac{2}{5}$ being lost in the appendages.

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The Morphology and Histology of *Piper Betle*, Linn. (the Betel-vine). By H. M. CHIBBER, M.A., Agricultural College, Poona, India. (Communicated by HAROLD H. MANN, D.Sc., F.L.S.)

(PLATES **17–19** & 1 Text-figure.)

[Read 19th December, 1912.]

INTRODUCTION.

PIPER BETLE, Linn. (the Betel-vine) belongs to the Natural Order Piperaceæ. It is largely cultivated in various parts of the East, viz., the Indo-Malayan Peninsula, Madagascar, and Bourbon. In the New World its cultivation is restricted to the West Indies *. The species is a native of the Malay Archipelago †.

The growth-form of the plant is that of a liane climbing by adventitious roots. The plant in its natural haunts, occupying as it probably did the summit of a tropical rain forest, must at one time have been exposed to the full blaze of a tropical sun. Under cultivation—in parts of India, at any rate—the plant is grown under the shade of other plants, and the individuals are close together so as to form poorly lighted humid *Mallas* or groves. This change in habitat could not but have produced some effect on the structure of the plant. The Betel-leaf plant thus forms a particularly interesting subject for a structural investigation which aims at ascertaining what characters are phyletic and what are physiological, and of the latter what are adapted to the natural earlier habitat in the forests and what to the artificial modern one created by man. With our present knowledge of the subjects of morphology and histology it is not possible to arrive at final answers to these questions. But it is obvious that before these could be given, accurate and detailed accounts of the structure of as many plants as may be possible should be available. What follows is a contribution to the list. An attempt is made at the end to interpret, from an ecological standpoint, the facts of the morphology and histology of the plant.

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* Engler and Prantl, 'Die natürlichen Pflanzenfamilien,' vol. iii. pt. 1, pp. 3–11.

† A. De Candolle, in his 'Origin of Cultivated Plants,' gives the Malay Archipelago as the home of this plant, and takes it to have been under cultivation for more than two thousand years. Sir George Watt, in the 'Standard Cyclopedia of Modern Agriculture,' vol. ix. p. 200, mentions Java as the probable home of this plant. Mr. J. C. Konigsberger, Director of the Botanical Gardens, Buitenzorg, informs me by letter that this species has not yet been found in the wild state in any part of Java, and adds that it is, however, growing wild in Celebes, probably also in the Moluccas.

MORPHOLOGY.

Roots.

As the Betel-vine is always propagated by cuttings of the shoot, the roots found in plantations are necessarily adventitious. These arise at the nodes of the stems and cuttings. The roots on the shoot act, above ground, as climbing organs, adhering as they do to the supports. The attachment to the support is effected by root-hairs. The roots bearing these arise in two circles—one just above and the other just below the insertion of a leaf. The upper circle of each pair appears first (Pl. **17.** fig. 1). This circle is incomplete, because of the axillary bud which fills up the gap. Each circle is made of an irregular number of roots, usually varying from six to twelve. Such of these as secure a support grow further into a branched system (Pl. **17.** fig. 5), the remainder shrivel up. The lower circle of roots is at times suppressed.

The underground roots do not attain to a great size, as the same part of the vine does not persist beyond three or four years. Their thickness hardly exceeds 6 millimetres. They are freely branching and spread out in the upper layers of the soil.

Shoots.

As the plant is vegetatively multiplied by cuttings, the shoots are never a direct growth of the plumule. All shoots are therefore fundamentally lateral. Yet shoots in different positions show differences in their structure, thus constituting different growth-types.

The plant is a root-climber, as already stated. All the shoots are, however, not provided with the climbing apparatus; it is only the shoots that start from the parts buried for propagation and run straight upwards—in other words, the main shoots—that are so provided. They run up to any height from 3 to 10 m., according to facilities for climbing. They bear lateral branches along their whole length. Again, the lateral branches borne within a couple of feet from the ground differ from those borne higher up. Thus we get three types of shoots, which may be termed respectively (1) the leaders, (2) the middle and top branches, (3) the ground branches. They may now be described in detail.

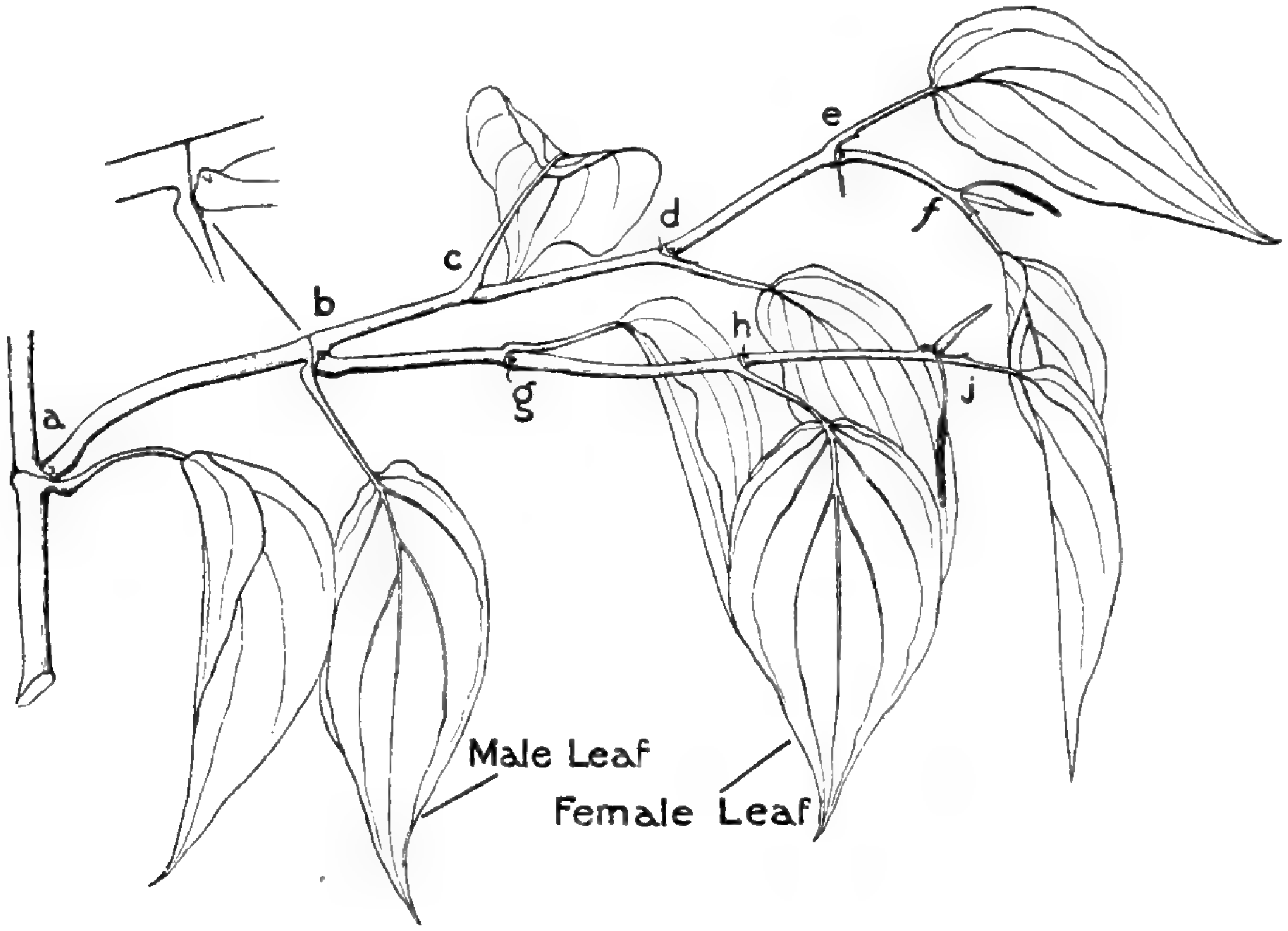
Leader.—Each leader is monopodial in construction. The internodes generally attain a length of about 12 cm. and a diameter of 1·2 cm. They are almost terete, being very slightly flattened. One of the flattened faces is opposed to the support. When young they are light green and marked by short, raised, whitish streaks. These show the location of the stomata. In older parts lenticels take their place.

The nodes are marked by an annulation caused by the stipules; above and below this ring we get the climbing roots, already described. The leaf-insertion is alternate and distichous. All the leaves are of one kind. The buds are axillary. The nodes get tumid when old (Pl. **17**. fig. 13). The leader is never observed to bear flowers.

Middle and Top Branches.—These are sympodial in structure. The flowers are restricted to them. Besides normal foliage, they bear scale-leaves reduced to sheaths.

Their disposition is almost horizontal. Each sympodial section consists of two internodes (Pl. **17**. fig. 6). The lower one is extremely short, averaging only 1 mm. in length. The node over this small internode bears a sheathing scale, in the axil of which there is a tiny bud. The second internode is a normal one, measuring 5–7 cm. The node over it bears a normal leaf. The axis after this turns sideways, either to form a minute extremely slender cylindrical evanescent body 5 mm. in length (text-fig. 1, points *d*, *g*, and *h*) or an inflorescence which either drops off prematurely (as it would from point *e* in the figure) or develops to its full size. The minute body is obviously an aborted inflorescence. An almost typical lateral branch is shown in text-fig. 1. If the node at *c* had developed as at *g* it would represent a quite typical form. It starts, as all branches do, with the abbreviated internode. Then there should be two elongated internodes (in the figure there are three), followed by a regular alternation of short and long internodes. At the second node, where the first normal leaf of the branch

Text-fig. 1.



is formed, the axillary bud develops into a branch as vigorous as the parent branch. Thus we get a forked shoot with a common stalk (portion *a* to *b* in the figure).

Such forks constitute the prevailing form of these branches. Variations, however, are not uncommon: one of these consists in the secondary branch of the fork placing itself in a line with the mother-axis, thereby forming a sympodial joint. This sympodial joint differs from the ordinary sympodial joints in the continued growth of the main axis into a foliage-bearing branch, instead of into a normal or vestigial inflorescence.

Should growth be vigorous, another variation may be found. This consists in a lateral branch system behaving like the leader in the following manner. After it has taken its start, like all branches, with the formation of the first short internode and the sheathing leaf at the node just succeeding it, it continues to grow as a monopodial branch, though very much zigzag, with fully elongated internodes and normal broad distichous leaves at the nodes for eight or nine joints. From a number of these joints in regular succession, starting from the very first normal leaf, branches arise; these from the beginning are typically sympodial. The primary branch further agrees with the leader in developing adhering roots; but this development is very occasional. Another variation is just the reverse of the last one. In this case the lateral remains a single shoot, the secondary branch which constitutes a side shoot being absent. Such single branches are very common; in fact, where growth is not quite satisfactory, such single branches are the most prevalent. Occasionally other variations occur.

Ground Branches.—These agree in structure with the middle and top branches, but are differentiated from them by the following developmental peculiarities.

The long internodes are greatly stunted in their growth (Pl. **17**. fig. 12). Their basal portions get tumid: the swelling is most pronounced on the under side and causes the part above the swelling to erect itself, as is found in a *Polygonum*; their disposition is outwards and upwards. These branches have always a dendroid look. They branch freely, which helps to intensify the dendroid appearance, as do their stunted dark thick leaves of inverted saucer-like shape. The short internodes here more regularly alternate with the long ones. Two branches may appear to start from one node; they really start from the two nodes approximated on either side of the abbreviated internode. The floral development, though provided for in the sympodial structure, is invariably arrested. From their proximity to the ground, one would expect profuse development of roots at the nodes. Nothing of the kind, however, is to be found. This fact appears to be the more striking when one sees the leader giving off from its nodes, 6 inches or even more above the ground, roots that are able to descend to the soil.

The following points, as regards branching, may be summarized from the above description. Branches, monopodial or sympodial, always begin with an abbreviated internode. The node succeeding any abbreviated internode always bears a mere sheath. Flower-production, which may, however, be aborted, is always correlated with sympodial structure. The sympodial unit has always one or more elongated internodes in a line with the main axis, as also one sheath and as many leaves as there are long internodes.

Branch-casting.—This requires a brief notice. Under natural conditions, before the time arrives for branch-casting the whole vine is lowered by the cultivators and buried. The phenomenon of branch-casting does not therefore normally occur under field conditions; it can, however, be easily contrived by placing a sufficient length of the vine in a moist chamber. A branch borne by the leader comes off from the first node above the short internode, leaving that internode invariably attached to the mother axis (Pl. **17.** fig. 13 at the apex). Higher up the branch, too, wherever there are two approximated nodes, the severance takes place at the upper node.

Buds.

Situation.—The bud is invariably axillary, whether on the leader or on the branches. All leaves and sheaths are provided with a bud. On the other hand, accessory buds are not formed. In accordance with these facts, we get, in the course of a branch at the sympodial joint where two nodes are approximated, a bud at the upper node alone. As this one bears the caducous sheath, the bud is always exposed to view. No bud is to be seen or expected at the lower node of the two approximated ones, *i. e.* in the axil of the ordinary leaf, for the bud which was there has already developed to form the sympodial unit lying over the lower node; in other words, it is the starting-point of a sympodium. The buds in the axil of all sheath-bearing nodes are situated so as to point either directly or obliquely upwards.

Development.—The buds in different parts of the plant have definite characteristics in this respect. The terminal bud of the leader will be considered first. Its growth is continuous, so that below the bud we get a regular gradation in size both of the internodes and leaves (Pl. **17.** fig. 1). The terminal bud of a lateral branch, on the other hand, develops by stages. It halts at every sheath, which, as we have seen, almost regularly alternates with a leaf, and does not unfold until the last regular leaf attains, or nears the attainment of, its full size.

As regards the axillary buds on the leader, such of them as are to develop into lateral branches start their development without any period of rest preceding it; hence we find a succession of lateral shoots on the leader below its apex developed in a graded manner, the smallest being uppermost (Pl. **17.** fig. 1).

Of the axillary buds on the lateral branches, those in the axil of a leaf either develop at once after formation (text-fig. 1, points *b* to *j* except *e*) or remain practically permanently dormant (point *e*). The position of the branch so developed may be sympodial (text-fig. 1, branch *g*, *h*, and *j*), either accidentally or of necessity, or it may be lateral. When such a branch is developed, the direction of the main axis, if it persists and does not turn into an inflorescence or any semblance of it, is one of the following. It is either in a line with its basal internode (text-fig. 1, point *b*) or it is quite turned out of its course by the daughter-axis; or, lastly and most frequently, both the main and the daughter axes stand more or less equally out of the axial line formed by the prolongation of their common base.

The lateral buds in the axil of a sheath have always a period of rest between their formation and sprouting. Besides, all such buds on a branch or even on a succession of branches develop simultaneously.

Appearance at various stages of growth.—The terminal bud of the leader always appears growing, its growth, as already stated, being continuous. The young parts are protected by the stipules of that leaf the blade of which is last exposed (Pl. **17.** fig. 1).

Regarding the terminal bud of the developed lateral branches, its appearance varies with its structure and stages of growth. For a time the stipules of the blade last unfolded protect it as in the last case (Pl. **17.** fig. 2). Soon, however, the bud outgrows the accommodation within the stipules. At this stage it is found enveloped by the sheathing leaf, when such is present; this sheath, we have seen, succeeds a normal leaf at an extremely short distance. In this condition (Pl. **17.** fig. 2 and tips of branches in text-fig. 1, p. 359) it rests until the last expanded leaf develops to almost its full size, when the sheath bursts open to let out the next normal leaf. By this arrangement the young inflorescence is exposed at a very early stage; for, being outside the stipules of the leaf inserted at its own level (Pl. **17.** fig. 2), from the moment the sheath of the preceding node prepares to drop off there is nothing to cover it. The inflorescence provides itself against this defect by early lignification of its parts. Regarding the axillary buds, all are protected by a sheath, since the first leaf of a branch is always a sheath, as already stated (Pl. **17.** fig. 6 for the resting condition). The axillary buds on the leader, that sprout immediately after their formation, show a gradation of size as we traverse a succession of internodes (Pl. **17.** fig. 1: at the last point it is too small to be seen from the side view). No such gradation is to be seen in the case of the buds in the axil of the sheath on the lateral branches; they sprout almost simultaneously.

Leaves.

There are two things to be considered here: the leaf proper and the structure forming a mere sheath, but equivalent to a leaf. The terms "leaf" and "sheath" will be respectively used for these structures.

The Phyllotaxis.—It is always alternate. On the leader which bears only leaves and no sheaths the arrangement is distichous. The axis when young is distinctly but slightly flattened, and the two orthostichies run along either end of the long diameter. As regards the lateral branches we have to consider each sympodial unit by itself, for an apparently single straight branch is not a morphological unit in the case of a sympodium. The sympodial unit usually consists, as we have seen, of two nodes, the lower bearing a sheath and the upper a leaf. The angle of divergence between the sheath and the leaf is usually one of 45°. When the sympodial unit consists of more than two nodes, the lowest one bears a sheath as before and the others a leaf proper. The angle of divergence between the sheath and the first leaf is again one of 45°, but that between the leaves proper is usually one of 180° (text-fig. 1, p. 359, axis *a* to *d*).

As regards the insertion of succeeding sympodial units, they are so arranged that, the branch being horizontal, the sheaths always come to be placed more or less upwards, while the bases of the leaves are generally on one or both flanks (Pl. **17.** fig. 6).

Leaves proper.—The *base* goes right round the stem. The mark left on the axis by a fallen leaf is crescentic. The horns of the crescent meet by a line round the stem, left by the fallen stipules. Hence we get a complete ring-mark on the stem. The base does not show any characteristic swelling, such as is found in leaves performing phototropic movements.

The *stipules* (Pl. **17.** fig. 1) are adnate to the axis as first stated; they are adnate to the petiole as well, and that almost throughout their length. They are connate at the base as they meet each other round the stem on the side opposite the leaf-stalk, forming a short collar to the axis. This collar is pale green, membranous, and only about 1·5 mm. high. The stipules are connate again at their tips. The part adnate to the petiole is membranous, and measures about 2·5 cm. in length: its breadth at the base, where it is greatest, is about 3 mm.; at the apex it becomes reduced gradually to a point. As the stipules are functional only at an early stage, the function being that of protection of the bud, they drop off early and leave a scar along the lines of attachment to the axis and petiole. As the petiole elongates after this, often doubling its former length, the original continuous scar breaks up into a broad broken line.

The *petiole* is generally plano-convex in transverse section, with a central groove along the plane upper surface. The groove at the base, where it is bounded by the diverging stipular ridges, is deep. Towards the middle of its length the petiole shows hardly any groove, while the upper one-third shows a distinct groove which deepens towards the apex. Variations from the above type freely occur; the petiole may be fluted, for example. The length of the petiole varies greatly, the average may be put down at 6·25 cm. Its surface looks like that of the leader-axis.

The *lamina*. The blade is simple, thick, coriaceous and ovate-cordate. The surfaces are glabrous to the naked eye; the upper one is deep green and shining, while the lower is light green and dull. The margin is entire and distinctly but very narrowly recurved.

As to the base, two distinct types occur: in one it is distinctly cordate and even, in the other it is acute and oblique. The groove along the upper surface of the petiole broadens out here into a triangular notch. The apex is acute or shortly acuminate. The blade may or may not be symmetrical. The relations between length and breadth of the blade vary very much, so as to give rise to two distinct shapes, which may be described as broadly ovate and ovate-oblong (Pl. **17.** figs. 3 & 4). The former may measure 16·25 cm. by 12·5 cm. and the latter 15 cm. by 8·75 cm. As regards the veins, they are pale white and freely projecting on the lower surface. The midrib at its base projects prominently on the upper surface as well for about 2·5 cm., while there is a faint indication of projection on the upper surface as regards the rest of the midrib and all the veins. The number of secondary veins varies from three to five or more on either side. All except one pair start immediately from the base, which thereby becomes palmate. The single pair which is left out of the base is inserted within an inch of it. In the leaf with a cordate base (Pl. **17.** fig. 3) the veins are very symmetrically arranged on either side of the midrib. In the oblique type (Pl. **17**. fig. 4) this symmetry is disturbed in two ways: their origin is not opposite, but somewhat alternate, and their distance from the midrib at any level along their course is unequal. Both these disturbances in symmetry are very marked in the case of the solitary uppermost pair. A leaf that is perfectly symmetrical in outline and venation is known in the Deccan as a female leaf and highly prized by fastidious eaters of the leaves. A leaf that is defective in this respect is known as a male leaf. All the secondary ribs are arcuate; the topmost and isolated pair takes a parabolic course. This pair terminates in the apex of the leaf, where they meet each other. The lowest or outermost pair merges into a marginal vein. The intermediate pairs arch very strongly towards their tips upwards, and unite with a tertiary vein given off by a secondary immediately over it. The tertiary veins fall into two groups: one group is constituted by veins given off by the secondaries on their outer or convex side, which are just a little thinner than the secondaries that give rise to them. These are also arcuate, and are so disposed as to form a succession of overlapping arches gradually reduced in size upwards. The other group is constituted by what may be termed the cross-ties *. They occupy the whole of the central arches on either side of the midrib and the lower parts of the other arches (Pl. **17.** figs. 3 & 4).

The *sheath* has the shape of a hollow cone slit open on one side lengthwise. It is faintly strigose, light green, membranous. When held up against light it shows about a dozen translucent lines. These are the mucilage-canals that traverse it lengthwise. The length of a sheath varies according to its position on the plant and vigour of growth up to 30 mm.

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* See the terminology of Dr. H. M. Ward in his 'Trees,' vol. ii.

The Flowers[*].—The individual flowers are very minute and unisexual. So far I have not come across a single plant of the female sex[†]. The male flowers form a pendulous cylindrical catkin (Pl. **17.** fig. 7). The stalk of the catkin measures about 2 cm. and the catkin itself 10 cm. in length and 2 mm. in diameter. The flowers are extremely reduced, consisting as they do of a couple of stamens inserted in the axil of a bract. The bracts are arranged in a thickly crowded spiral series, as in a pine cone (Pl. **17.** fig. 8). Each bract is peltate, with a short stalk (Pl. **17.** fig. 9). The stalk bears simple or uniseriate multicellular hairs done up in bunches. Of the stamens, the filament is extremely short, and resembles, and is not delimited from, the connective (Pl. **17.** fig. 10). It measures 1 mm. in height. It is oval in outline and not cylindrical as filaments generally are. The longer axis of the oval measures 2 mm. and the shorter less than 1 mm. The anther in the immature state shows four loculi arranged in a cross (Pl. **17.** fig. 11); when mature the cavities run together. The pollen-grains in the dry state are oval and measure 11 μ by 9 μ. The mature inflorescence is strongly aromatic; the aroma is peculiar in itself, but reminds me most of *Michelia Champaca*[‡].

HISTOLOGY.

Leaves.

Upper Epidermis.—This epidermis is many-layered. It cannot be peeled off[§] by a simple act of tearing the leaf. The usual number of layers is three. All the layers are derived from the dermatogen: this is characteristic of the natural order to which the plant belongs. When young the lateral walls of the epidermal and hypodermal cells coincide with one another (Pl. **19.** fig. 35). As growth proceeds, the number of epidermal cells increases by the formation of new lateral walls. This results in the epidermal cells acquiring a smaller size than the hypodermal cells (Pl. **18.** fig. 22). The cells of the epidermal layer are isodiametric in surface-view, the diameter measuring about 45 μ *; in height they average only 15 μ. Their lateral walls are quite straight. Stomata are absent from this surface; but the epidermis is diversified by the basal cells of hairs and by peculiar aggregations of small cells, the significance of which is rather obscure.

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[*] Stray inflorescences occur throughout the year, but the regular flowering-time is April and May, *i. e.* the hot season preceding the monsoon.

[†] Dr. Harold H. Mann, Principal, Agricultural College, Poona, suggests that it may be the result of selection of male plants by the cultivators at one time, when fruiting of the vines may have seriously interfered with vegetative growth.

[‡] References: 'Flora of British India,' by Sir J. D. Hooker, vol. v. p. 85, and the references quoted there.

[§] The epidermis of leaves peels off most readily from either surface, as a rule, in the cases of mesophytes and succulent xerophytes.

Regarding the hypodermal cells they are not only larger in surface-view, as mentioned above, but also in height (Pl. **18**. fig. 22). In a slightly wilted condition their lateral walls show bellows-like foldings. This indicates a provision for reducing the size of the lumina of the cells of this aqueous tissue when necessary. When fully expanded, the height of the cells of the hypoderma measures about 45 μ, *i. e.* three times that of the epidermal cells.

The hypoderma is diversified by the presence of secretory cells (Pl. **19**. fig. 35). These are spherical in outline, measure about 27 μ across, and contain among other things an essential oil. One of their peculiarities lies in acquiring full dimensions from almost the beginning. Thus in a leaf measuring 2·5 cm. in length the hypodermal cells appeared cubical and only 9 μ across, *i. e.* one-fifth their full size; while the secretory cells measured full 27 μ across, *i. e.* their maximum size. Occasionally hypodermal cells show peculiar thickenings of the walls (Pl. **18**. fig. 26). They often look like tubercular swellings. Several may arise at a junction of cells and meet together by their bases. They are best seen in surface-sections. Their significance is obscure. They are probably silicified. They recall the peg-like processes to be seen in the epidermal cells adjoining the guard-cells on the walls common to both in *Penæa myrtoides* and *Sarcocolla fucata* of the natural order Penæaceæ †. The hypodermal layers are close-packed, no intercellular spaces being present.

Outer Wall of Epidermis.—The outer wall is well developed on the upper surface. It measures about 4 μ in thickness. It is homogeneous and free from all tuberosities or striations; hence the upper surface looks polished and glossy.

Hairs.—The hairs are of one type only. Omitting the stalk-cell, they would be unicellular. They number about 1200 to a square centimetre. They are inserted in very shallow depressions. The stalk-cell is very peculiar (Pl. **18**. fig. 17); its cavity is hourglass-shaped, with the difference that the lower or inner bulb is larger than the upper or outer bulb. The larger bulb is sometimes flattened out (fig. 19). The walls are very peculiarly thickened. The base and apex are left unthickened. The maximum thickening is in the region of constriction. The cell thence broadens both upwards and downwards. Upwards it broadens into an eccentric funnel. The mouth of this funnel measures about 8 μ in diameter, while its bore is 3 μ. Downwards it broadens into an angular body (Pl. **18.** fig. 21). The thickened parts of the wall are cutinised (fig. 17).

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* All microscopic measurements have been taken with the ocular and stage micrometers, and drawings have been made with an Abbe Camera lucida.

† Solereder's 'Systematic Anatomy of Dicotyledons,' Engl. Trans. p. 722.

The cell constituting the body of the hair lies horizontally and is oval in outline (Pl. **18.** fig. 20). From a surface-view it measures about 45 μ by 12 μ. It is inserted nearer one end. The two ends are not quite symmetrical; the proximal end is more rounded, and the distal end or free tip is bluntly pointed and sometimes shows lamellated thickening (Pl. **18.** fig. 15). In height the cell measures as much as it does in breadth. The cell is so orientated that the extending slope of the eccentric funnel points towards its longer tapering arm. With reference to the entire leaf they have not any definite direction. Although the basal cell lies in a shallow depression, the back of the hair slightly projects above the general surface (Pl. **18.** fig. 17). The hairs just described are of the nature of hydathodes; they readily absorbed colouring-matter when the leaf was immersed in an extremely dilute solution of methylene-blue (1 in 500,000). This indicates * an ability to absorb water from outside when necessary and available. The funnel-like thickening of the basal cell seems to be intended to facilitate the passage of water either way. The cell constituting the body of the hair strongly reminds one of similar hairs (hydathodes? †) found on the leaves of *Camptothera acuminata*, Decne., among the Cornaceæ.

Small-celled patches.—These are constituted by the epidermal cells forming an aggregation of cells that are characterised by their small size, being about a fourth of the usual size of normal epidermal cells. A patch generally measures 60 μ across. The cells vary in their frequency from 200 to 400 per square centimetre. They also differ greatly in their structure. In the simplest case there is nothing remarkable, except the small size; in other cases one or more of the hydathodes may be included within its limits. Another difference may be in one or more of the cells appearing more refractive than the rest, and finely dotted. Lastly, such an aggregation may lie distinctly above the general surface; it focuses, when examined from surface-view, differently from the rest of the epidermis and a part of its edge does not fit in with the surrounding cells, but it clearly overlaps them.

The hypodermal cells lying beneath the patches are also modified, in as much as their walls are thickened and strongly silicified. On the other hand, the epidermal cells are thin-walled. It is highly probable that these patches form an apparatus accessory to the hydathodes, but it is not clear how they operate; the silicification of the hypodermal cells is intended to prevent collapse of the water-tissue. This is analogous to the occurrence of idioblasts or spicular cells in the mesophyll of many plants, *e. g.* those of *Simaruba* *.

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* Warming's 'Œcology of Plants,' Engl. ed. p. 345.

† Solereder's 'Systematic Anatomy of Dicotyledons,' Engl. Trans. p. 436.

Lower Epidermis (Pl. **18**. fig. 14).—This differs from the upper epidermis in the following points. It, together with the hypoderma, can be peeled off by a simple act of tearing the leaf in an oblique fashion. The peculiar small-celled patches are absent; the hypodermal layer is only one cell thick; stomata are present; and, finally, the hairy covering consists of hairs of three types. These are the hydathodes, pearl-glands, and unicellular or uniseriate clothing-hairs. The hydathodes are precisely the same as those on the upper surface. The pearl-glands appear only temporarily and irregularly. In plants grown in the groves they are to be found on only some of the leaves, and that too in small groups here and there. They appear in greater profusion on leaves that have been plucked and kept moist for some days. As many as three hundred were counted on one such leaf. These glands form large glistening spheres varying from one-half to one and a half mm. in diameter. They are filled with proteid and fatty substances. They are readily detachable, whether they are fully developed or immature. They are regarded as food-bodies †, corresponding biologically to those on the tips of the leaflets of *Acacia cornigera*. The clothing-hairs are restricted to the veins. They are of the same character as those on the petiole and the young stem. They will be fully described later on.

The epidermal cells are about the same length as in the upper epidermis, but the breadth is somewhat reduced, so that, instead of looking squarish, they have, generally speaking, an oblong shape (Pl. **18**. fig. 14). The height is the same as in the case of the upper epidermis. The dimensions of a typical cell may be put down as 45 by 24 by 15 μ. The lateral walls are straight or slightly curved, but never sinuate. The curve is very pronounced in the case of the accessory cells round a stoma.

The stomata are more or less uniformly distributed. They number about five to six thousand per square centimetre. They have not any definite direction with reference to the leaf, nor is there any regular distance between them. Two of them may abut against each other, forming twin stomata, or a whole square measuring 300 μ either way may not have a single stoma within it. The guard-cells are invariably surrounded by a circle of subsidiary cells ‡; their number is generally four. Often an additional or outer circle of such cells is observed. The inner ring of subsidiary cells is cut off from the cell which forms the mother-cell of the guard-cells. The preparatory divisions take place usually in four radii. The stomatal type therefore approaches that in the Cruciferæ [*], in which, too, there is a subsidiary ring similarly developed, but it is of three cells instead of four. The outer ring, when present, is contributed by the surrounding cells. The guard-cells are crescentic as usual, and measure 24 μ in length and 7 μ in breadth when the stoma is moderately open. They are on a level with the rest of the epidermal cells. They do not show any special thickening or protrusions.

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* Solereder, Syst. Anat. Dicot., Engl. Trans. p. 183; also compare the following: "In Javanese rain-forests, according to Haberlandt, several species, including *Gonocarium pyriforme* and *Anamirta Cocculus*, contain in their collenchyma mechanical cells, precisely as do certain xerophytes" (Warming, Œcol. Pl., Engl. ed. p. 344).

† Solereder, *l. c.* p. 690.

‡ The presence of a peripheral water-tissue entails the formation of accessory cells in connection with the stomata, according to Benecke (see Warming, *l. c.* p. 125).

The lower hypodermal layer, as already stated, is only one cell thick. This layer also, like the upper one, is derived from the dermatogen. Its cells cease to divide earlier than those of the epidermis, so that in a section of a young leaf there are to be seen about twice as many epidermal cells as hypodermal ones. On the other hand, the number of cells in both the upper hypodermal layers corresponds with that in the upper epidermis at the same stage (Pl. **19.** fig. 35). The cells of the lower hypoderma about this time look columnar in a transverse section, their height being about as much as that of the two layers on the other side taken together, or twice to thrice as much as that of the epidermal cells lying in contact with it. At this stage there are no intercellular spaces to be seen. The secretory cells, however, make a very early appearance and acquire full size almost from the beginning.

The fully developed leaf shows large intercellular spaces or respiratory chambers in this lower hypodermal layer. They are of all sizes and shapes. In surface-view the most prominent ones are circular and measure about 65 μ across. They generally lie over the stomata. Wherever there are secretory cells the ordinary cells seem to radiate towards them; the secretory cell looks like a hub round which there are about six somewhat wedge-like radiating cells to form the spokes.

Mesophyll.—The mesophyll is of the bifacial type. The palisade-tissue is irregularly stratified. The maximum number of strata is two. Whenever the two strata are developed there is an encroachment on the hypodermal layer, the thickness of which is reduced to one cell thereat (Pl. **18.** fig. 22). The double strata are short and few. The greater length of a section shows only a single layer or stratum of palisade-cells. The cells are roughly cylindrical in outline, and measure on an average 40 μ by 12 μ; they are close-set. The only intercellular spaces present are those that a bundle of cylinders would naturally enclose (Pl. **18.** fig. 16). When two strata are present, the height of the double layer is roughly twice that of the single layer, and the cells of the two layers are of equal height. The regularity of the palisade-layer may be broken by the presence of the ubiquitous secretory cells. The cell-walls are free from all markings.

The spongy tissue is made up of irregularly rounded cells. The smaller veins principally traverse this region. The secretory cells also are present here.

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[*] Solereder, Syst. Anat. Dicot., Engl. Trans. p. 59.

The entire assimilatory tissue is characterised by the presence of large amounts of calcium oxalate in the cells, both in the form of well-formed crystals and fine sand. The leaf is free from any structures like water-pores, chalk-glands, spicular cells, or storage tracheids.

Relative development of the Aqueous and Assimilatory Tissues.—The aqueous tissue constituted by the hypoderma and epidermis on either side is made up of five tiers or layers of cells altogether. In a fully developed leaf, which was 222 μ thick, the upper aqueous tissue measured 63 μ and the lower 54 μ. This left 105 μ to the assimilatory tissue, of which the palisade measured 40 μ and the spongy tissue 65 μ. Thus aqueous and assimilatory tissues stood at 117 μ and 105 μ respectively. Hence the two may roughly be said to contribute equally to form the thickness of the adult leaf.

On examining a young leaf, it was found that these proportions do not hold good (Pl. **19.** fig. 35). There the aqueous tissue was noticed to be much nearer its full size than the assimilatory tissue, in which, on account of absence of elongation in the palisade-cells, the two layers, palisade and spongy, could not be differentiated. The actual figures are given below :—

Upper aqueous tissue 51 μ; assimilatory tissue 63 μ; lower aqueous tissue 42 μ; entire thickness of the leaf 156 μ; entire aqueous tissue 93 μ.

Midrib.—A section of the midrib taken before it gives off the last or uppermost two secondary ribs is traversed by three large and a variable number (0 to 4) of smaller vascular bundles, all arranged in a crescent. The vessels have scalariform markings. There is a large mucilage-canal lying above the central bundle. It may measure 150 μ across. The hypoderma of the blade is here substituted by collenchyma. A section of the midrib after it has given off all the secondary ribs shows only a single bundle. The mucilage-canal persists within an inch or two of the leaf-apex.

Secondary Veins.—These project freely on the under side of the leaf. A section of one of them agrees with that of the midrib taken at a point above the origin of the secondaries, with the exception that the mucilage-canal is absent in the secondary vein.

Finer Veins.—The finer veins are embedded in the spongy parenchyma. They are not vertically transcurrent by any specialised tissue. They ultimately lose themselves in fine terminations that end freely. The extremity is formed by one or more fusiform tracheids ensheathed by short rectangular thin-walled cells. These cells, further away from the termination, give place to much elongated thin-walled cells forming a very distinct aqueous sheath to the veins. The tracheids are very variable in form. It is not unusual to find one of them forming a three-rayed star at a junction of three veins (Pl. **18.** fig. 25).

The precise disposition of the terminals and the value of this character in systematic histology cannot be estimated at present, for it has not been systematically worked out.

Leaf-Margin.—The margin, which is always more or less strongly recurved, is characterised by the absence from it of the assimilatory tissue. It is the line of union of the hypodermas of the two surfaces. The cells in this region have somewhat thickened walls, but there is no differentiation of collenchyma or sclerenchyma, as is the case with many leaves having recurved margins. The assimilatory tissue abutting on the margin is particularly rich in secretory cells; it also contains a marginal vein running through it.

Petiole (Pl. **19**. fig. 33).—A section of the petiole through the characteristic region *, *i. e.* at the point nearest the blade, has the following characters. The outline is very variable. The following generalisation, however, can be made. The lower border is convex. It may or may not be variously lobed. The upper border is either flat or slightly notched, or deeply grooved along the middle.

The epidermis is of the same character as that of the stem to be described below.

Within the epidermis there is a very narrow band, only two or four cells thick, of parenchyma containing chloroplasts. On it abuts the collenchyma-zone, which is not a continuous girdle, but is divided into a variable number of arcs. The usual number is eight or nine. These arcs are separated by narrow bridges of parenchyma half a dozen cells broad. Within the collenchyma lies a mass of parenchyma, which encloses intercellular spaces. Secretory cells permeate the parenchyma throughout; they are particularly abundant in the immediate neighbourhood of the collenchyma-arcs, both within and without them. The centre of the section is occupied by a single large mucilage-canal. Round it are arranged in a crescent, which may close up into a circle, the vascular bundles. They are graded in size. The three largest lie on the underside, *i. e.*, between the lower convex border and the centre, forming a small open arc. The arc is continued laterally upwards by two more bundles on either side, which are smaller than the three bottom ones. The arc may or may not be completed into a circle by two or three very small bundles lying on the upper side, *i. e.*, between the upper border and the centre. Between the seven major bundles there may or may not be intercalated tiny bundles, one between each two. These may either fall in the same circle as that of the main bundles or they may lie outwards so as to form an independent outer circle of their own; or, finally, some may be in one position and some in the other.

Regarding the orientation of the bundles, the xylem points towards the centre and the phloem towards the circumference. This rule, however, is not always observed; occasionally a solitary bundle may be found orientated at right angles to the normal position, so that the dividing-line between xylem and phloem forms a radius instead of a tangent. The larger bundles have a starch-sheath, which is incomplete on the inner or xylem side. It is one cell thick, and suggests the structure of the petiole to be schizostelic.

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* See Petit's terminology quoted in Solereder's Syst. Anat. Dicot., Engl. Trans. p. 1094.

The phloem is characterised by the presence of the secretory cells within its limits.

The cells lying just outside the xylem and phloem ends of the bundle have definitely thickened walls, but no trace of lignification could be detected. A section through the initial or basal region of the petiole differs from that through the apical or characteristic region in the following points.

There is a larger number of small bundles that are intercalated between the principal ones. There may be a mucilage-canal for every major bundle, *i. e.*, about seven of them; these lie in the same radius as the bundle, almost abutting on it on the xylem side. The bridges of ordinary cortical cells between the collenchyma-arcs are widened into a second set of arcs intercalated between the former. The collenchyma on the upper side of the section is replaced by tabular parenchyma, the walls of which are thickened and the radial arrangement of which strongly reminds one of tabular cork-cells; the walls, however, are of cellulose. This zone of tabular parenchyma is much deeper than the replaced collenchyma, being about twelve cells deep.

Stems: Primary Structure.

A transverse section near the apical region reveals the following points. To begin with the centre, this is occupied by a well-differentiated mucilage-canal (Pl. **19.** fig. 36). Its lysigenous origin is clearly indicated at this stage by loose cells lying about in the cavity (Pl. **18.** fig. 30). The cells bounding it do not form a distinct epithelium; they show some granules within their cavities besides mucilage. The mucilage is true gum, being completely soluble in water. It readily stains with methylene-blue. Next, there may be noticed the mucilage-canals lying in the peripheral part of the medulla. These, however, are slower to appear than the central canal, nor do they appear simultaneously. In the section reproduced (Pl. **19.** fig. 36) four of them are well formed, in one the cavity is very narrow but distinct; while one more does not show any formation of cavity, but it is indicated only by the group of cells, destined to form the canal, retaining their nuclei and possessing contents that stain deeply with methylene-blue or hæmatoxylin. The same section shows in the medulla the secretory cells freely scattered throughout. These, however, are not so clearly differentiated as the mucilage-canals, for in the section we can make out three distinct mucilage-canals; but the major part of it is free from any indication of the future numerous secretory cells. The section also indicates the very early differentiation of the vascular strands. They are ranged in two distinct rings. The inner one lies within the circle of mucilage-canals in the medulla. These are the medullary vascular bundles; they vary in number usually from six to twelve. When their number is small they form one irregular circle in the ground-tissue, so that the ring becomes sinuate, but not distinctly double. They vary in size, especially when they are numerous, and then those that are crowded out are smaller than the inner ones; nor are they in such a case evenly spaced, as some of them get too close to each other. The bundles are collateral in type; they are usually normally orientated. However, when their number is large, the outer ones may be twisted out of the normal position through an angle of 90°, so that the line between the xylem and phloem comes to be a radius instead of being a tangent. In shape they are almost circular at this stage. There is not any strict relation between the vascular bundles and the mucilage-canals either as regards number or as regards position; however, in some sections a mucilage-canal is observed in all the radii occupied by the crowded-out bundles. Lignification of the annular and spiral vessels has been observed within a hundred microns of the apex. The pith is limited by a sinuate zone of cells which are destined to form a sclerenchymatous ring. It is clearly indicated in sections from near the apex by the smaller size of the cells; but, unlike the vessels, they are not sclerosed at this early stage. It is about four to five cells deep. The peripheral vascular bundles are directly applied to this ring. They are very unequal in size. There are about five or six large bundles approximately equidistant from one another. They project prominently out of the circle of the remaining bundles towards the pith, and push the sclerenchymatous ring inwards in so doing: hence the latter is thrown into deep sinuations. Besides the larger bundles there is a variable number of small bundles, from 12 to 24 or more. Many of these appear in the transverse section as tiny specks. Some of the smaller bundles that are comparatively large project slightly inwards so as to produce gentle undulations in the fibrous ring. All these bundles constituting the peripheral ring are strictly normally orientated.

The spaces between the bundles are occupied by parenchymatous cells; these differ from similar cells of the pith in their smaller size and greater closeness. Outside the ring there is a narrow pericyclic zone, about five cells deep, of parenchyma, which agrees with that of the medulla. It is bounded externally by the single complete circle of endodermal cells. The radial walls show the characteristic cog-like thickening. Their contents are marked by the presence of starch-grains.

The cortex outside the endodermis is characterized by particular abundance of secretory cells within it. It also contains collenchyma, which is in the form of isolated arcs separated by broad radii of parenchyma, which are, as it were, ties connecting the parenchyma lying on either side of the collenchyma-arcs. The parenchyma-ring outside the collenchyma is only two or three cells deep. This ring also is characterized by an abundance of the secretory cells.

The epidermis is best studied in a surface-section. The cells are very unequal. The lateral walls are straight. The hairy covering is composed of hydathodes and simple hairs. The latter are either unicellular or uniseriate multicellular (Pl. **18**. fig. 23). They are either mere bosses or short conical structures. Their breadth at the base is 12 μ; their length varies from 10 to 50 μ. When multicellular, the number of cells is usually two or three. They are free from any crystalline contents or incrustations. When full-grown, they contain nothing beyond cell-sap. Their number is too small to form a definite covering or to impart to the surface any pilose appearance. The young stem is strigose, with short broken whitish lines. These lines mark the position of the stomata (Pl. **18**. fig. 24); they are of the same character as those on the leaf, but appear somewhat elongated when their long axis coincides with that of the stem.

Stems: Structure after the Formation of Secondary Growth.

Mucilage-Canals.—A fully-formed axis shows a central canal and about a dozen peripheral canals situated in the ground-tissue just outside the medullary bundles. They have a diameter of 250 μ. Occasionally the centre is occupied by two canals lying close to each other.

Pith.—The parenchyma of pith is made up of three elements:—(1) Ordinary parenchymatous cells, enclosing intercellular spaces. Their diameter in a transverse section measures about 45 μ. Their height is variable, but it is often twice the breadth. Many of them contain definite single crystals or mere crystalline sand, or both, composed of calcium oxalate. (2) Stone-cells: These are freely and regularly scattered through the cellulose parenchyma. They have the same height as the latter, but have a distinctly larger diameter, it being 60 μ. Their walls are thickened to 6 μ. They have simple oval pits, which measure 3 μ in breadth; their length is variable, but it is generally double the breadth, *i. e.* 6 μ. The stone-cells do not form any definite groups. Towards the centre they may occur completely isolated; towards the periphery, just within and abutting on the inner sclerenchymatous ring, they form a continuous zone about five cells broad. This sclerosed parenchyma encloses intercellular spaces, just like the cellulose parenchyma. (3) Secretory cells: These are larger than those in the leaf, being about 50 μ across. About fifty of them may be seen in a transverse section.

Medullary Bundles.—Of these there may be as many as twenty in an old piece about 9 millimetres in diameter. They are arranged in a sinuous ring, or they may be regarded as arranged in two rings, an outer and an inner one, which greatly overlap each other. The peripheral mucilage-canals are sometimes situated opposite the bundles constituting the outer ring. The shape of a bundle in transverse section is broadly triangular (Pl. **18**. fig. 27). Its breadth may amount to 0·6 mm. and radial length to 0·7 mm. Each bundle has usually half a dozen large vessels. The outline of a vessel is circular. The diameter may measure 225 μ; the minimum diameter observed was only 20 μ. The walls have scalariform markings surrounded by simple borders. The pits are very narrow and elongated. The height of a cell composing the vessel is 400 μ. The scalariform vessels are surrounded by narrow pitted vessels or tracheids only 30 μ across. They are very abundant. The pits are simple and broadly oval. Besides these there are the primary annular, spiral, and annulo-spiral vessels. These are very varied. The rings of annular vessels may be close-set or sparse and circular or hexagonal. An annular vessel may be found to show irregularly spiral markings for a part of its course, or an annular vessel may be continued as a spiral one, thus constituting an annulo-spiral vessel. Of spiral vessels, there may be a single spiral or there may be two or more of them. When more than one, they may either run together or cross each other. Sometimes a single band is seen to split for a part of its course into two. The spiral band may be somewhat open or quite close; it may be thick or thin. The endings of the component cells are either gradually tapering or truncate.

Other xylem elements of a bundle are wood-parenchyma and wood-prosenchyma; both these are scanty. Wood-parenchyma is cylindrical in outline. The cells measure 30 μ to 60 μ by 30 μ; their walls bear numerous simple oval pits. The larger pits measure 7 μ by 3 μ; all of them invariably have their long axis horizontally directed. Wood-prosenchyma is septate, with thin transverse partitions of cellulose. A loculus of such a cell measures 200 μ to 300 μ by 15 μ to 20 μ. The end walls of a prosenchyma-cell are either tapering or truncate. The side walls are marked with simple pits, which are much smaller and fewer than in the sclerosed parenchyma. The smaller of them measure only 1 micron, and look very much like the markings of the cuticle of an earthworm. The larger ones form obliquely-directed slits measuring 2 to 4 μ by 1 μ. Sclerenchymatous fibres are also present, forming short arcs tipping the bast and wood extremities of the bundles. They are from one to a few layers deep. The arc at the xylem extremity is more extended, being almost semicircular. The component fibres are septate, like the prosenchyma, with thin transverse partitions of cellulose. The periphery of the partition is, however, thickened and lignified. A fibre measures about 1 mm. in length and 15 μ in diameter. The length of a chamber is only about 250 μ. The walls of a fibre towards its middle are 5 μ thick. Transitional forms between the sclerenchymatous fibres and wood-prosenchyma also occur.

The bast is made up of the usual elements, viz., sieve-tubes, their companion cells, and bast-parenchyma. But the last is freely interspersed with secretory cells. These are, unlike those in the rest of the plant, greatly elongated in the vertical direction. They may measure 45 μ by 15 μ. The sieve-tubes carry the sieve-plates only on the transverse walls. They may be quite horizontal or more or less obliquely directed. The apertures are very fine and uniformly distributed. Several sieve-plates, sometimes as many as twenty, may be seen in one transverse section of a bundle. This is due to the sieve-tubes, which are of about the same length, possessing a tier-like arrangement. The length of each tier of tubes is generally found to be 520 μ. The diameter of the tube measures 45 μ at the most, while that of the companion cells is only 6 μ.

A strip of cambium is interposed between the xylem and phloem sections of the bundles. Typical cambium cells measure 9 μ radially and 21 μ tangentially.

Peripheral ring of Bundles.—The number of bundles in this ring, in an old piece about 9 mm. diameter, may be as great as fifty. They lie strictly in a single circle. Their orientation is always normal. They are, in a transverse section, oval in outline (Pl. **18.** fig. 28); their longer diameter may amount to 1 mm.; the breadth in that case is usually a third of the length. The smaller bundles are somewhat circular in outline, and measure only a fourth of a millimetre across. The number of scalariform vessels in a bundle varies from one to twelve. Their lumina are narrower than those of the medullary bundles. The larger of them average about 100 μ. The sieve-tubes of these bundles are also narrower than those of the other or medullary set (30 μ across) and fewer in number. These bundles otherwise agree with those of the medullary ring.

Towards the pith, this peripheral ring of bundles rests on an undulating sclerenchymatous zone. This zone is thickest opposite the larger bundles, where it also dips inwards towards the pith. The thickest part is some twelve cells broad, while to the thinnest part there go only two to three cells. It is continuous and homogeneous. The fibres composing it are chambered with transverse partitions of cellulose. Their diameter varies from 10 μ to 25 μ.

The bundles are separated by broad medullary rays. The breadth of the rays measures from 100 μ to 500 μ. The cells are typically lignified; the walls have simple oval pits, like the sclerosed parenchyma of the pith. The outlines of the cells are rectangular, and the intercellular spaces are also regular rectangles extending along the entire radius of a ray. The height of the cells is very uniform, and all the cells in one plane are often precisely in one level. In other words, they are arranged in regular tiers; and longitudinal sections along a ray reveal horizontal straight lines passing throughout the ray. The tangential dimensions have also the same characters; so that in a transverse section we see radial rows of cells between any two bundles. The vertical walls of these cells measure 60 μ, and their tangential walls 20 μ. The radial walls are not so regular as the tangent and vertical ones. Most of the cells are, however, radially elongated (30 μ). The rayed arrangement is not restricted to the part lying between two masses of xylem, but it extends between the phloem positions of the bundles, crosses the outer sclerenchyma-ring, and reappears in the cortex that lies in a line with the medullary rays.

The vascular ring is surrounded by an outer sheath of sclerenchyma. It is, unlike the inner sheath, composite in structure ; the composing constituents are bast-fibres, which form semilunar groups about three to six fibres deep outside the bast and sclerosed parenchymatous bands, one to two cells deep, which link the hard bast across the medullary rays. But their distinctive places are not strictly retained by the cells and fibres, as they are often met with freely intermixed. The cells are somewhat irregular in shape. Usually the vertical and tangential walls are equal to each other and double the radial walls.

This composite ring is reinforced along the middle line of most of the medullary rays by buttresses of sclerosed parenchyma projecting inwards into the latter. These cells have the same dimensions as those of the ring proper; but the relative sizes of the radial and tangential walls are in this case reversed, the radial walls being double the tangential walls. Occasionally such a buttress projects far inwards, traversing the greater depth of the medullary ray. The outline of this outer sheath is crenulate, on account of its strong convexity opposite each phloem mass.

When medullary rays are lignified, the lignification extends from the inner to the outer sheath of the sclerenchyma.

Cortex.—The endodermis persists as a continuous ring of cells, with the cog-like suberised thickenings on the radial walls. The typical cortical cells measure 45 μ across. The rayed arrangement of its cells opposite the medullary rays has already been noticed. The secretory cells are present, if not abundant, and are somewhat larger than the ordinary parenchyma of the cortex. The parenchyma-layer is rather thin, being about 150 μ. It is succeeded by bundles of collenchyma, which appear in the form of detached arcs. These are about 75 μ deep. The component cells are only 15 μ across. The thickening of the walls of some of them takes the form of fibres of sclerenchyma (Pl. **18**. fig. 31). These are chambered and pitted as the fibres elsewhere, but are extremely narrow, being only 6 μ across. They attain a length of 800 μ. Occasionally the cortex is traversed by a few small concentric cortical bundles. The xylem occupies a peripheral position in such a bundle (Pl. **18**. fig. 29).

As regards storage of reserve materials, starch may be seen at certain times of the year in almost every cell of the stele and cortex, except the large vessels.

The formation of cork takes place in the outermost layer of the cortex. The cork-cells are radially compressed. Their radial walls measure 10 to 12 μ, tangent walls 20 to 24 μ, and vertical walls 20 to 24 μ. But the cells are often irregularly angular instead of rectangular, when the above measurements do not hold good.

Lenticels.—These arise by masses of cortical cells becoming secondarily merismetic. They soon enlarge, so as to rupture the regular cork-layer lying over them. The fully-formed lenticels cause oval concave depressions in the cortex.

Roots.

The general appearance of a transverse section of an old piece of root strongly reminds one of the stem of the woody Aristolochias, in which, "in the course of growth in thickness, broad secondary medullary rays are successively developed in the vascular bundles themselves, occasioning a dichotomous fission of the plates of wood and bast composing the vascular bundles" *. In the section reproduced (Pl. **19.** fig. 37) there can be seen six primary medullary rays. The intervening xylem-plates have bifurcated once or twice. The centre of the section is occupied by ligneous elements.

The vascular elements are the same as those in the stem, and they have the same markings and peculiarities.

The medullary rays are about twelve cells broad ; the cells are more regular than those in the stem. Here all the walls, including the radial ones, have somewhat the same length and almost the same level. Again, in the stem the radial walls exceeded the tangent walls. In the root the tangent walls exceed the radial ones, the former being 15 μ and the latter 10 μ. Their height is about 55 μ. The secretory cells, which are absent from the stem rays, are here present, though very sparingly. Another difference in the rays is constituted by the absence of lignification.

The stele is limited by a sclerenchymatous ring. It is usually one cell thick, but is here and there reinforced by an additional layer on the inner side. The continuity of the ring is broken at some points by solitary passage-cells, *i. e.* unlignified thin-walled cells (Pl. **18.** fig. 32).

The cortex is better developed than in the stem. Starch may be present here as well. The secretory cells, which here attain a diameter of 60 μ, occur, though somewhat sparingly ; their walls may be lignified or suberised. The cork-layer is also better developed here ; the component cells have the same size as in the stem.

The Cell-Contents.

The cell-contents, so far as revealed by the microscope, may be briefly noticed here.

Starch-Grains.—The starch-grains range in size from less than one micron to nine microns in the longest diameter, and are roughly spherical in shape and angular in outline. They often appear grouped together in small or large numbers, and form balls of an irregular shape. The hilum cannot be made out. The lamellæ also cannot be discerned. No compound grains, unless these be the balls just referred to, occur. Regarding distribution of starch within the plant-body, a heavy deposit is to be seen in the root and stem at particular seasons. The precise cells containing starch have been mentioned in the preceding anatomical account of the root and stem.

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* Solereder, Syst. Anat. Dicot., Engl. Trans. p. 687.

Crystals of Calcium Oxalate.—These are met with in the general parenchyma of the entire plant. The epidermis and aqueous tissues do not contain any. The assimilatory cells of the leaf are particularly laden with this salt. No definite crystal sacs are formed. The crystals either take an oblong shape or appear as very minute particles, with Brownian movement. No crystals of other salts were observed.

Mucilage.—This occurs in regular canals of lysigenous origin. The canals are quite absent from the roots. In the normal lamina there is only one of these fully developed occupying the midrib. In the tissue of the leaves reduced to mere sheaths there are a dozen of them running lengthwise from base to apex. In the stem they occur in the parenchyma of the stele, as already described. The mucilage is completely soluble in water.

Potassium Nitrate.—This substance was found by my friend Mr. D. L. Sahasrabudhe, of the Chemical Department, Agricultural College, Poona, to occur in extraordinary abundance in various parts of the plant. It can be readily detected in the leaves and axis microchemically with diphenylamine and pure sulphuric acid.

Tannin.—As made out by the usual microchemical reagents for tannin, this occurs in very small quantities, since only very faint reactions can be obtained. No special tanniniferous cells occur.

Essential Oil.—Secretory cells containing an essential oil occur throughout the plant. In the leaf they are particularly abundant. They always occur singly. These cells are usually larger than the surrounding parenchyma. They attain their full size at a time when the neighbouring tissues are in an embryonic stage. The oil takes up a greater part of the space within the cell and forms, as a rule, a single large globule. Besides the oil the cell may contain starch-granules and crystalline particles of calcium oxalate. The best way to examine these secretory cells is to strip off the lower epidermis of the blade with the fingers. The aqueous tissue which is interspersed with these cells also comes off with the epidermis. With pure sulphuric acid the secretory cells give the following reactions. The oily contents at once turn yellow. Almost immediately the yellow changes into orange. The orange after two or three minutes changes into light crimson, and this after a few minutes (from 5 to 30) passes off into faint purple. By the time the crimson colour is developed the cells burst, liberating the contents.

INTERPRETATION OF THE MORPHOLOGICAL AND ANATOMICAL STRUCTURE OF THE PLANT.

The plant is a liane climbing by roots. It must have owed its origin, like all lianes, to "struggle for light assisted by abundance of moisture"[*]. Its xerophilous structure, as will be presently seen, points to its having occupied the summit of tropical rain-forests, fully exposed to the influence of strong light as well as strong insolation[†].

First of all, as regards the xerophilous points in structure, the glossy and coriaceous nature of the leaf-surface is intended to reflect strong light falling on it. The strongly developed jacket of aqueous tissue enveloping the mesophyll serves to cut off to a certain extent thermal rays from reaching the latter[‡]. It also serves to store up water against dry days. It is significant that the upper layer of this jacket is thicker than the lower layer. The irregular doubling of the palisade is inexplicable, save as a vestigial character. If then we are right in assuming the prototype of this cultivated plant to have possessed a regular double layer of palisade, cells, we have here a character which is always co-ordinated with strong illumination. Absence of stomata from the upper surface points, in conjunction with the other characters, to the horizontal disposition of the leaves in an environment where the dangers of excessive heat and light come from above, and not beneath as is the case with lithophilous vegetation.

Of the contents, mucilage[§] and ethereal oils[‖], both of which are abundant, concurrently point to the plant attempting to reduce transpiration and mollify the heat to which it must have been exposed. It is noteworthy, in connection with the secretory cells that store up if not manufacture ethereal oil, that in the stem and the petiole they are particularly abundant in the superficial tissues, and that in all cases they hasten to complete their development when the surrounding tissues are yet embryonic, in order to be able to extend protection to the latter when they need it most.

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[*] A. F. W. Schimper's 'Plant Geography,' Engl. ed. p. 309.

[†] "In structure of leaf and stem some lianes recall xerophytes; it seems quite natural that lianes should be exposed to the possibility of losing more water by transpiration than can be balanced by supplies from the root, and hence should be structurally adapted to provide for this contingency" (Warming, 'Œcology of Plants,' Engl. ed. p. 91).

"According to the investigations of Haberlandt and others, plants in Javanese rain-forests and possibly in the higher storeys of tropical rain-forest in general, are exposed to conditions far more extreme than are experienced by European vegetation .... This explains the remarkable fact that many plants in tropical rain-forests exhibit protective devices against excessive transpiration similar to those displayed by xerophytes" (Warming, p. 344).

[‡] "Voluminous peripheral water-tissue checks the penetration of heat rays rather than of luminous rays, and thereby retards transpiration in addition to acting as a water-reservoir" (Warming, p. 121).

[§] "Mucilage absorbs water readily, but parts with it very slowly, and is therefore manufactured by xerophytes in various organs ..." (Warming, p. 120).

[‖] "These oils evaporate more readily than water and surround the plant with aromatic air .... ethereal oils diminish insolation and consequently transpiration" (Warming, p. 107).

Regarding mucilage-canals, it is noteworthy that they are absent from the root. It is possible to infer from it, *inter alia*, that although the leaves are exposed to xerophytic surroundings the roots have not to deal with similar conditions, unlike those of a desert plant. Absence of lignification in the root to the extent observed in the stem points to the same inference. In the aerial parts the canals make their appearance very early. It is true they are absent from the blade (the solitary one in the midrib being dropped out of consideration) ; but it could be explained by the development of the water-jacket or aqueous tissue, which serves the purpose of mucilage, perhaps more efficiently. There is one more fact to notice regarding the distribution of these mucilage-canals. Though hardly represented in the blade, they are abundantly developed in the sheaths, which are obviously evolved for protection of the bud.

The absence of an air-containing tomentum is fully explained by the evolution of the several complementary devices reviewed above.

The hydathodes may next be noticed. They are known in plants to perform the double office of excretion as well as absorption of water. Their presence implies clearly that the plant is exposed to varying conditions of water-supply, now excessive, now deficient.

One thing more regarding the leaf *. The entire and recurved margin is characteristic of xerophilous plants †, and implies that the plant once grew under conditions very different from those it finds to-day under cultivation ‡.

Strong and early lignification in the stem is one more physiological character that points in the same direction §. In certain cases more than half of the pith-parenchyma is found sclerosed. All the bundles are tipped with fibres at either end. The outer ring of vessels is bounded on both sides by well-developed sheaths of sclerenchyma. Lignification also includes the broad medullary rays between peripheral bundles. Lastly, fibres are developed in the interior of collenchyma. One cannot expect a greater degree of lignification in a liane *.

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* Contrast the leaves of sclerophyllous plants (Schimper's 'Plant Geography,' pp. 510–12).

† Warming, 'Œcology of Plants,' Engl. ed. pp. 101 & 238.

‡ In parts of Gujarat the vines are trained on a horizontal platform (5 feet above ground) of dry sticks facing towards the sky without any shade or cover. In other places, *e.g.* Ratnagiri District, the vines are trained along the stems of isolated trees. The leaves in both cases are smaller in size and thicker in texture than those produced in a regular grove in the Deccan. The comparatively large size of the leaf is thus probably a secondary character resulting, *inter alia*, from the great humidity that undoubtedly prevails in a grove for the growth of betel-vines.

§ "The physiological reason for the strong development of lignified constituents is still somewhat obscure. But intense light and vigorous transpiration seem to be the causes" (Warming, p. 129).

I should like to express my indebtedness to Dr. Harold H. Mann, Principal, Agricultural College, Poona, and to Prof. William Burns, Economic Botanist, Bombay, Poona, for the interest they took and the encouragement they gave in the preparation of my work, as also for many valuable suggestions they made. To Prof. Burns further acknowledgments are due for his having kindly gone over the manuscript before the paper took its final form.

All the drawings for this paper excepting the micro-photographs were executed by Mr. K. R. Tilak, Artist to the Department of Agriculture, Bombay Presidency, to whom the thanks of the writer are due for the careful way they are done.

Agricultural College, Poona, India.
25th April, 1912.

EXPLANATION OF THE PLATES.

PLATE 17.

Fig. 1. Apical part of a leading shoot. × $\frac{3}{4}$.
2. Terminal bud of a lateral branch. × $\frac{3}{4}$.
3. Print of a leaf showing veins and outline; broadly ovate cordate type. Reduced.
4. Print of a leaf; ovate oblong type. Reduced.
5. A node showing the adhering roots. Natural size.
6. Another branch with the axillary buds resting (the sheathing leaves devoid of lamina being caducous are shown detached). × $\frac{3}{4}$.
7. Male catkin. Natural size.
8. Portion of 7. × 5.
9. Bract from behind, showing the stalk, shield, and hairs. × 5.
10. A stamen; semiprofile view. × 5.
11. Immature anther; face view. × 5.
12. A dendroid piece forming one of the ground branches. Natural size.
13. Branch-casting (for explanation, see text p. 361). Natural size.

PLATE 18.

Fig. 14. Lower epidermis of lamina. × 700.
15. Body-cell of a hydathode showing the tip lamellated. The two concentric circles refer to the stalk-cell. × 800.
16. Palisade-tissue, end view; treated with chloral hydrate. × 700.

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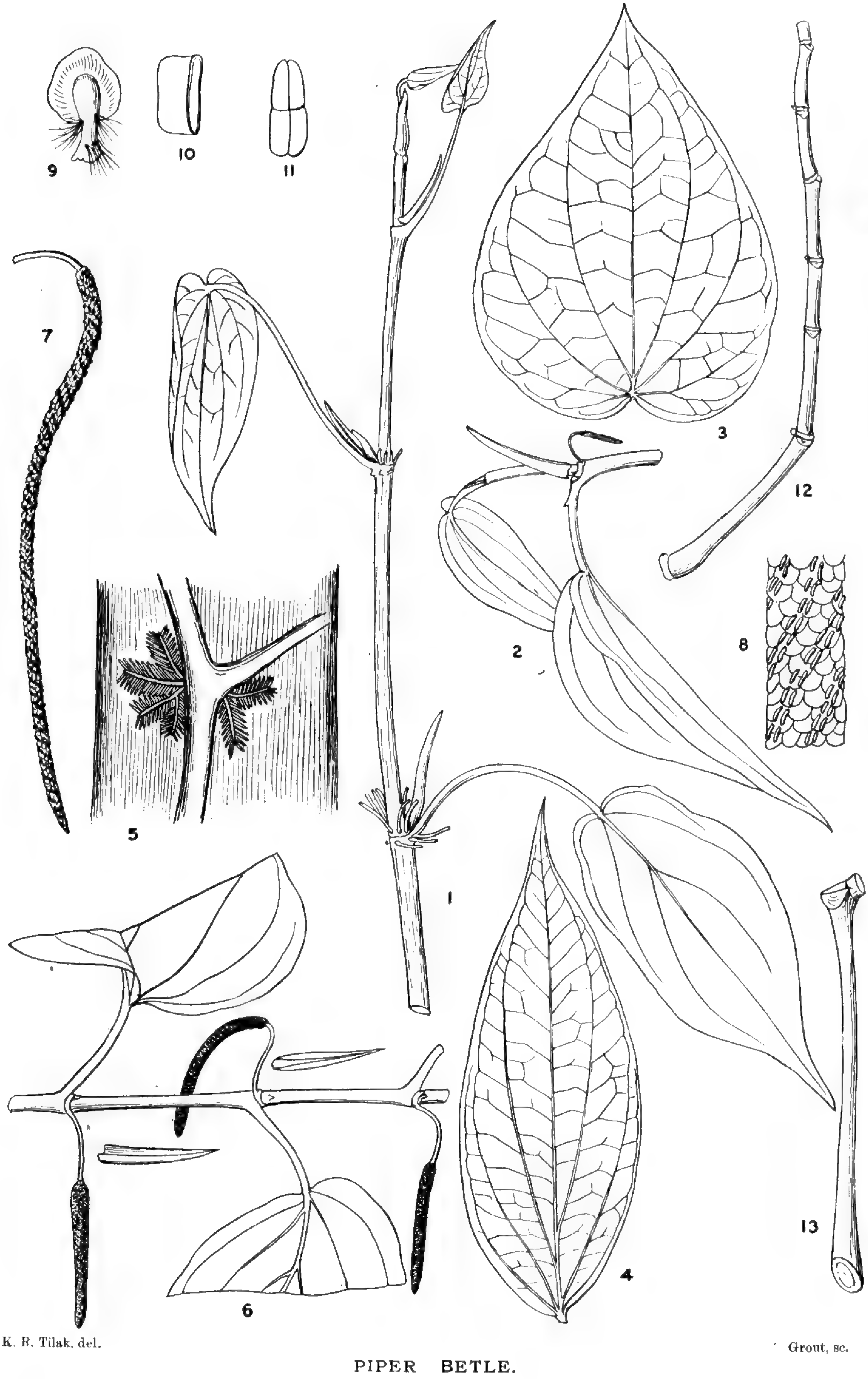
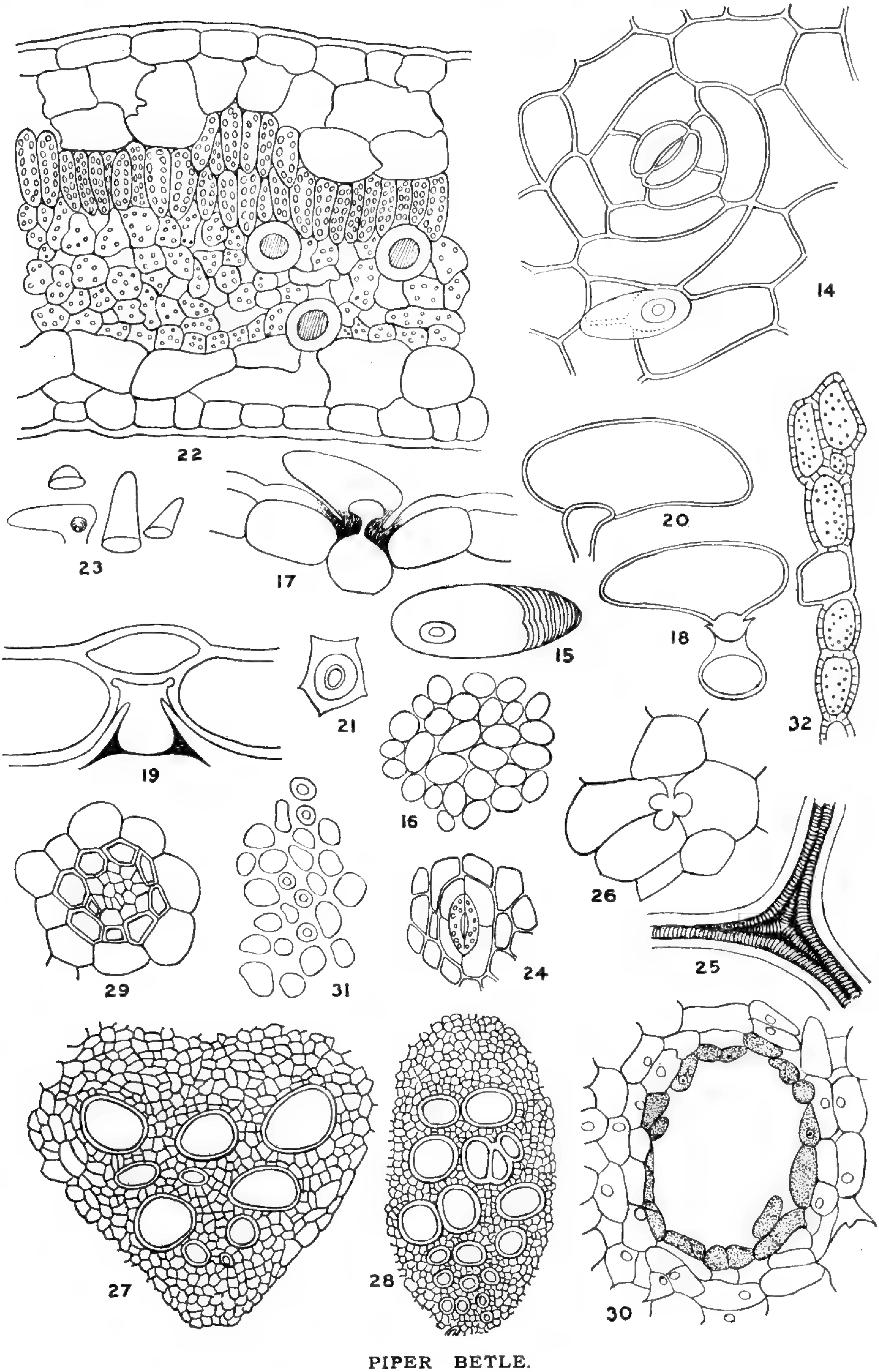
* For literature on Histology of this plant, see Solereder, Syst. Anat. Dicot., Engl. Trans. ii. p. 694.



K. R. Tilak, del. Grout, sc.

PIPER BETLE.



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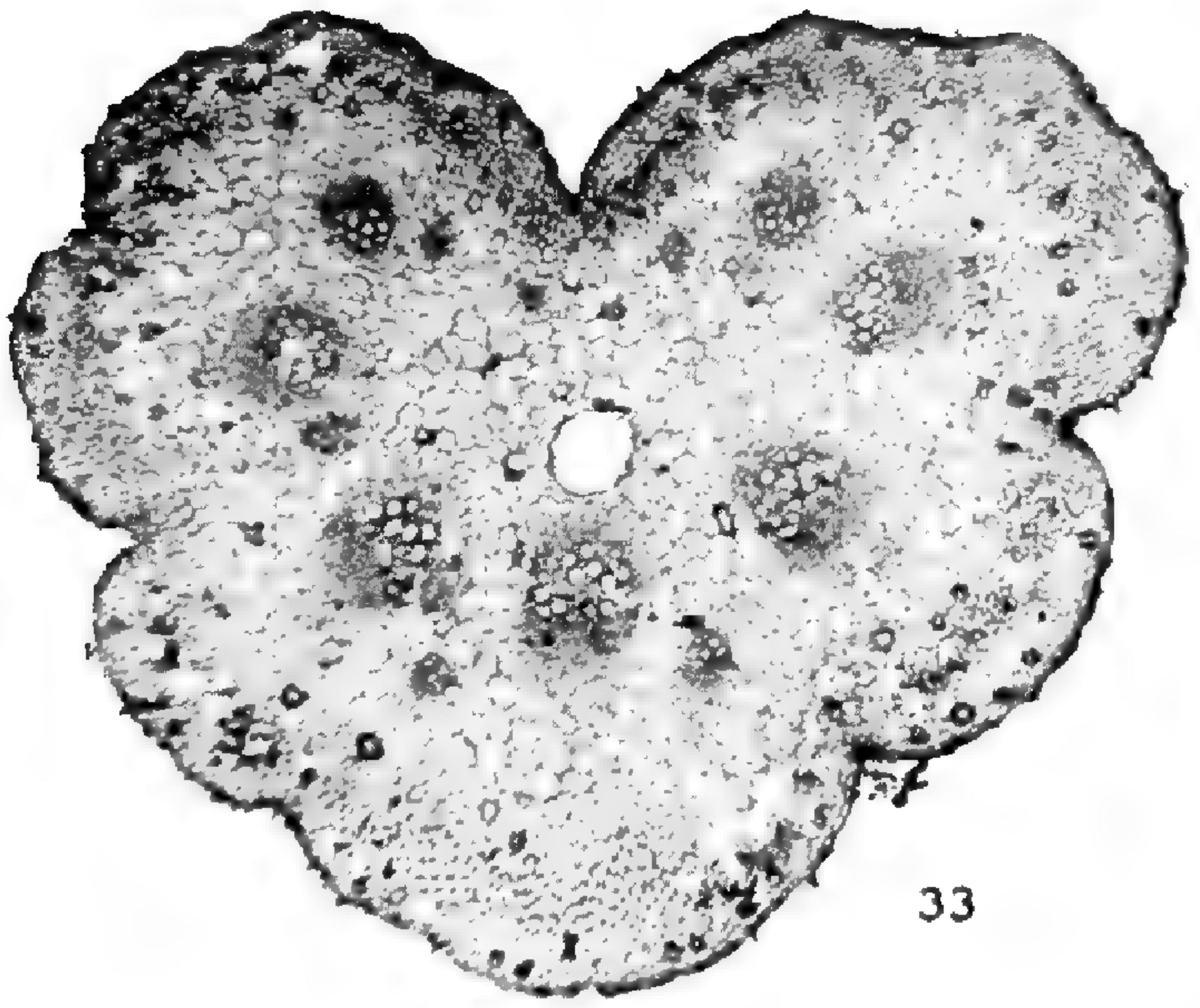

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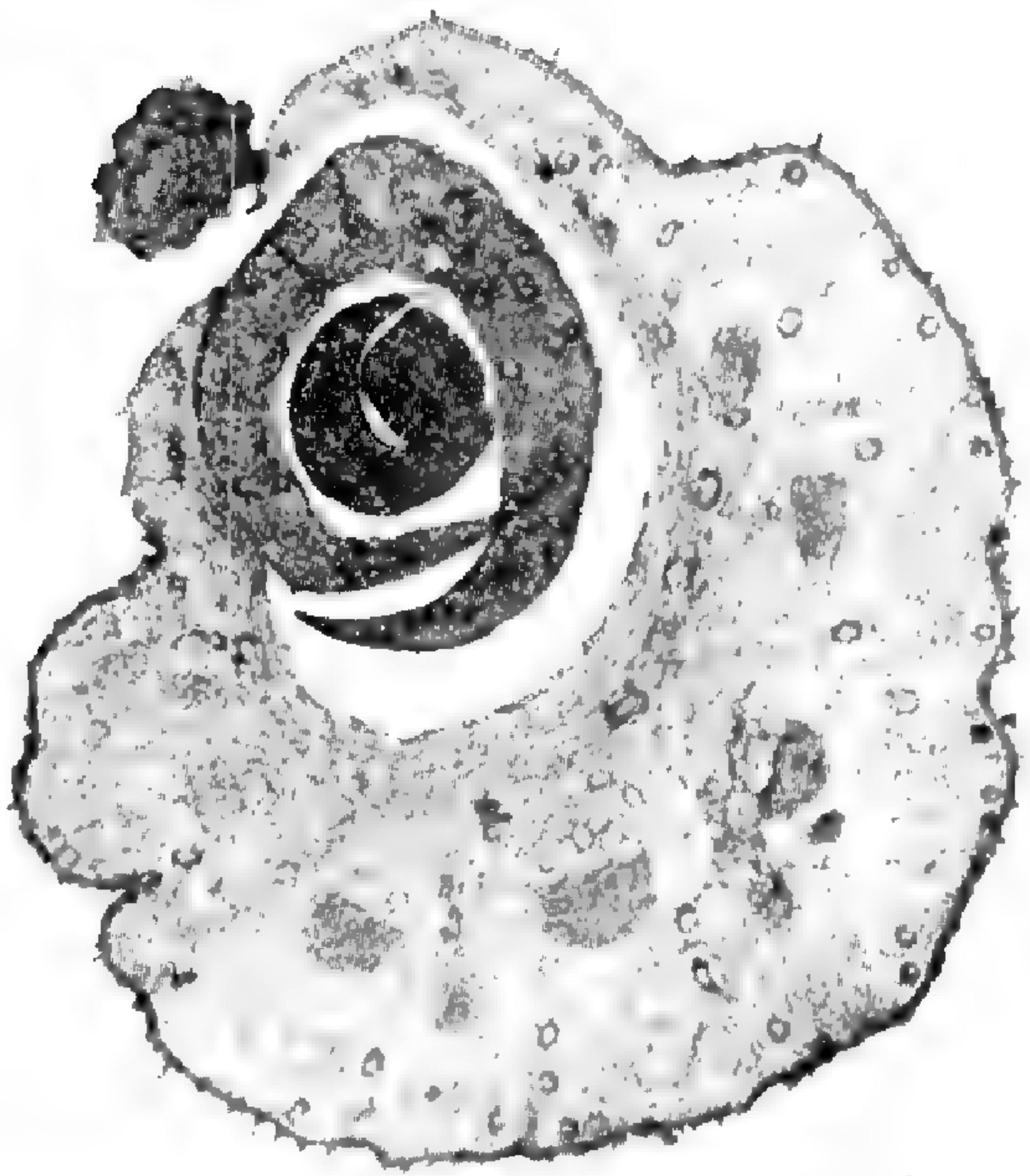

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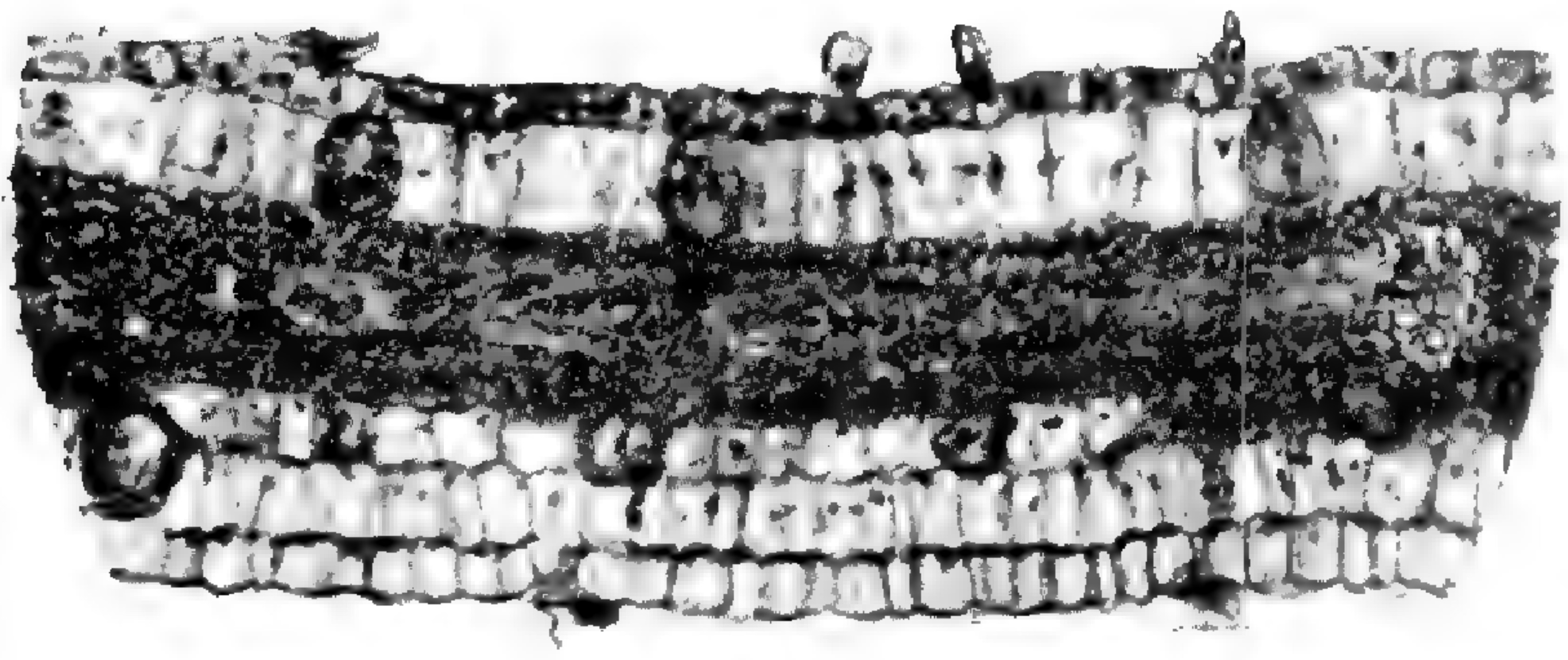

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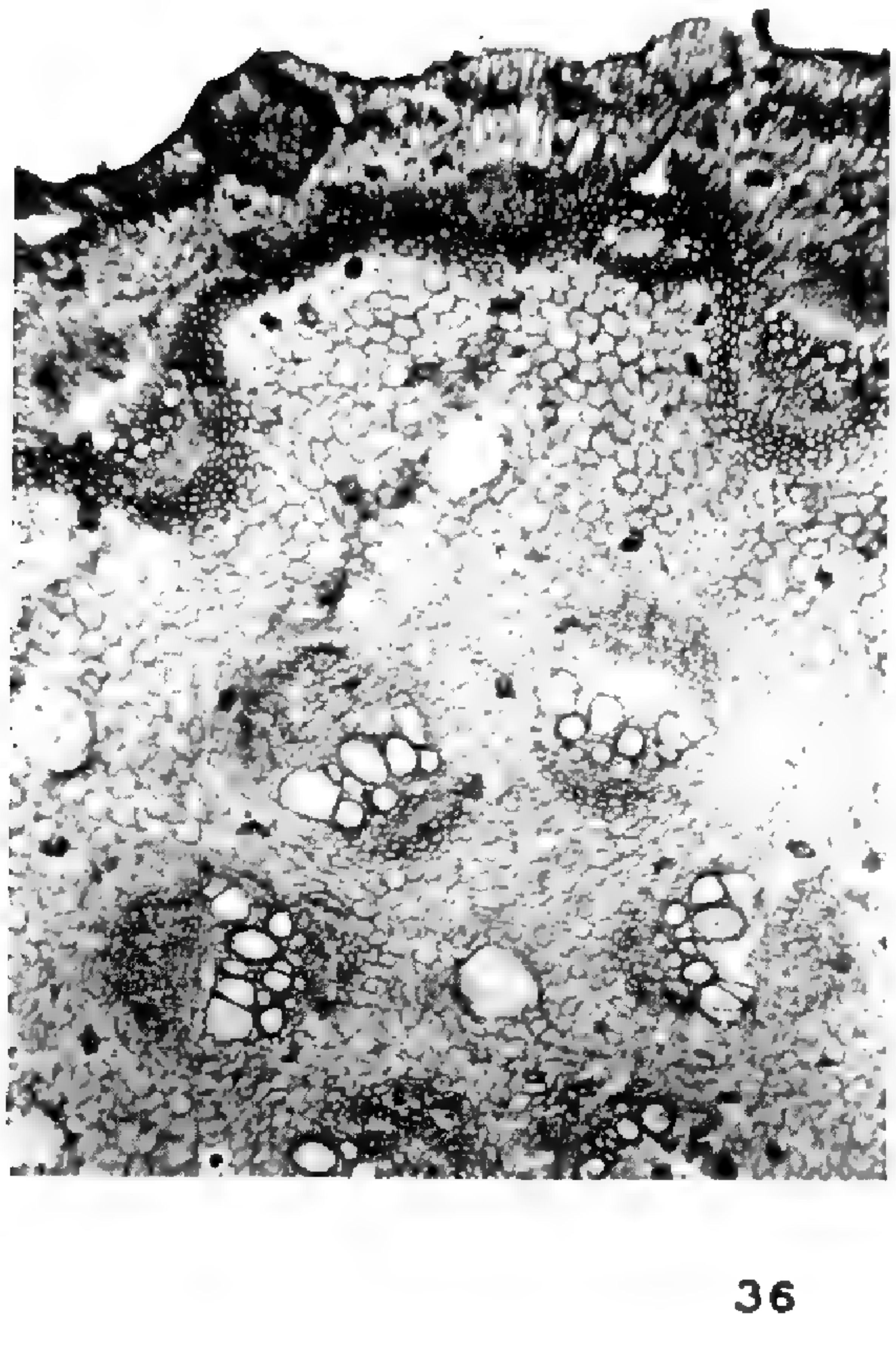

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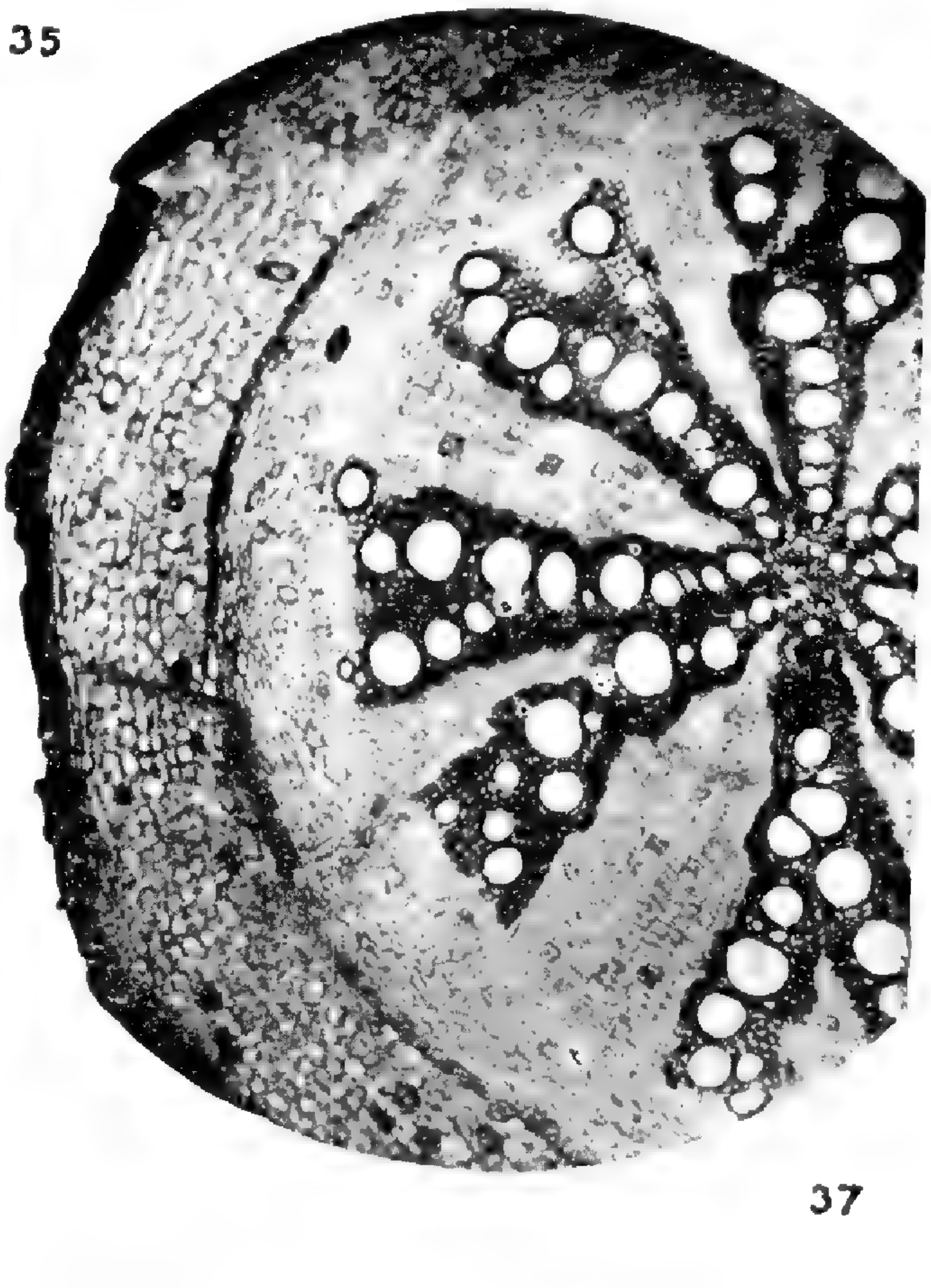

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PIPER BETLE.

Fig. 17. Hydathode with adjoining epidermal cells (early stage); side view. × 1100.

18. Hydathode (more advanced than 17). × 1100.

19. Hydathode (side view), fully formed. The figure is inverted, and the body-cell is omitted. × 1100.

20. Hydathode with the stalk-cell having a spout. × 1100.

21. Plan of the stalk-cell of a hydathode. The outer pentagon is the base, the next circle is the apex, and the inner two circles form the neck of the cell. × 1100.

22. Transverse section of the lamina, where the palisade-tissue is doubled for a short distance; it shows three secretory cells. × 330.

23. Isolated hairs from the stem. × 330.

24. Stoma from the stem. × 330.

25. A three-rayed tracheid at a junction of veins in the lamina. × 330.

26. A silicified (?) thickening in the upper hypoderma; see p. 366. × 330.

27. Vascular bundle from the medullary region of the stem. × 70.

28. Vascular bundle from the peripheral ring of the stem. × 70.

29. A cortical concentric bundle with peripheral xylem. × 330.

30. Transverse section of a mucilage-canal from the stem. × 330.

31. Collenchyma in the stem, showing formation of sclerenchymatous fibres within it (transverse section). × 330.

32. Endodermis in the root with a transfusion-cell (transverse section). × 330.

PLATE 19.

Fig. 33. Transverse section of a fluted petiole from the basal region just above the insertion of the stipules. × 30.

34. Transverse section of a branch near the apex. The oval piece lying outside is the terminal inflorescence of a sympodial system. The outer crescentic piece is a petiole cut across in the region of the stipules. The small intercalated bundles are to be seen between the larger ones. The middle crescentic piece is a sheath cut across. The inner crescentic piece is the next leaf. The central circular piece is the lateral axis arising from the axil of the outer leaf. × 40.

35. Transverse section of an undeveloped lamina. The figure is inverted. The hypoderma beneath the upper epidermis is double over only a portion of the section. The secretory cells are very conspicuous. The hydathodes can be seen along either border. × 166.

36. Transverse section of the stem (advanced stage), the stray spots are secretory cells. × 30.

37. Transverse section of an underground root. × 30.

An Account of the Plants collected by Mr. M. P. Price on the Carruthers-Miller-Price Expedition through North-West Mongolia and Chinese Dzungaria in 1910. By M. P. PRICE, M.A., and N. D. SIMPSON, B.A., F.R.M.S. (Communicated by Dr. O. STAPF, F.R.S., Sec.L.S.)

(With MAP and PLATES **21–23**.)

[Read 17th April, 1913.]

I.

OBSERVATIONS ON THE VEGETATION OF THE SIBERIAN-MONGOLIAN FRONTIER, THE NORTH-WEST MONGOLIAN PLATEAU, AND CHINESE DZUNGARIA.

By M. P. PRICE.

THE expedition which yielded the material for the present paper was undertaken during the spring and summer of 1910 in company with Mr. Douglas Carruthers and Mr. J. H. Miller, the former of whom contributed a paper on the geographical results of the expedition to the Royal Geographical Society's Journal in June 1912.

Botanical observations and collections were made by the writer of this section of the paper throughout the journey from Minnusinsk to the Siberian-Mongolian frontier and through N.W. Mongolia and Chinese Dzungaria until Kuldja was reached. A map showing the route of the expedition and the localities mentioned in the paper will be found on **Pl. 20.** It has been reprinted, with the addition of certain place-names, from the Journal of the Geographical Society, June 1912, with the permission of the Society. The plants collected by me have been worked out by Mr. N. D. Simpson, who has incorporated most of my field-notes in the part of the paper under his name. My thanks are due to the Royal Geographical Society for permission to reproduce the map, and to the Director of the Royal Gardens, Kew, for permitting Mr. Simpson to use the material in the Kew Herbarium.

A. THE BASIN OF THE UPPER YENISEI.

Itinerary and General Notes.

The Upper Yenisei plateau comprises an area drained by two rivers, called by the natives the Bei Kem and the Khua Kem, and is the upland from which the Siberian Yenisei River rises on the border of Siberia and Mongolia. The area is roughly 64,000 square miles, and the whole drainage area unites in one large stream called the Ulu Kem, and bursts through the mountain wall of the Sayansk range about 150 miles south of the Siberian town of Minnusinsk. The Sayansk mountains, which form the nominal frontier between Siberia and Mongolia, are not a true range in the strict sense of the word, but rather a series of disjointed uplifts, of which the highest peaks reach 8000 and 9000 feet in places, and are connected by numerous passes of from 4000 to 5000 feet in altitude. The trend of the range is indefinite, and many spurs jut out far into the Siberian forests on the north and into the plateau basin of the Bei Kem on the south. The average height of the floor of the basin is roughly between 2000 and 3000 feet, and it is thus everywhere surrounded, except at the point where the Ulu Kem bursts through the Sayansk mountains in a series of gorges and rapids, by a complete range of encircling mountains. To the south lie the Tannu-ola range, a complete barrier between the Yenisei basin and the North-West Mongolian plateau.

The plains of the Siberian lowlands at Minnusinsk average about 900 feet in altitude, and going southwards from here the traveller rises on to the first step of the Central Asiatic plateau, which is formed by the northern spurs of the Sayansk mountain system. This first step of the plateau is clothed on its northern slopes with dense forests, which in their floral type show affinity to the sub-arctic forest of Siberia some 400 miles to the north. The latter lies between the latitudes of 56° and 72°, and nowhere rises above 600 feet above the level of the sea. Similar conditions, however, are found on the Sayansk mountains between latitudes 52° and 54° at heights varying from 3000 to 5000 feet. Thus the same vegetations are found in northern latitudes at low altitudes, as in southern latitudes at higher altitudes. In other words altitude compensates for latitude. Between the sub-arctic forest belt of Central Siberia and the forests of the Sayansk mountains lie the steps of Minnusinsk and Abakansk in the Minnusinsk Government of Siberia. Here the dry steppe-like vegetation of Central Asia seems to have pushed its way in as a wedge between what may at one time have been a continuous zone of sub-arctic forest. As the glaciers retreated northwards a steppe-like vegetation crept evidently into the Siberian lowlands, which lie in southern latitudes, and have thus effectively isolated the floral system of the Sayansk.

In the Upper Yenisei plateau, besides the sub-arctic forest and a flora characteristic of northern Siberia, there is also the Siberian Larch forest with an accompanying floral association. The former prevails in a long strip along the north or Siberian side of the Sayansk system and in all the higher parts of the plateau where the winter is long and severe. The Larch forest, on the other hand, prevails in the lower altitudes and is indicative of a drier climatic condition. For in winter snow lies less deeply in the more southern latitudes and on the lower altitudes of the Upper Yenisei plateau, than on the northern slopes of the Sayansk. In the former places the summer rainfall is only assured by numerous sharp thunder-storms.

Separating the Yenisei basin from the plateau of North-West Mongolia lie the Tannu-ola mountains, in latitude 60–61°. They form the second step of the plateau, and after crossing them the traveller finds himself on the floor of the Mongolian desert plateau, which from this point southwards averages about 5000 feet in altitude.

The first section of the journey was undertaken from the Siberian lowlands across the Sayansk mountains and the Upper Yenisei plateau to the northern slopes of the Tannu-ola mountains. Ascending the Amil River, a tributary which flows into the Yenisei near Minnusinsk, the party, consisting of a caravan of 24 horses, reached the watershed between that river and the tributaries of the Upper Bei Kem in June 1910. After plunging through dense forests of Siberian pine and spruce, we crossed the Sayansk mountains by a low pass and reached the Upper Yenisei plateau. Descending the Sisti Kem tributary, we explored several of the valleys which drain the right bank of the Bei Kem. Several side expeditions were undertaken in boats, which in this district are made by the Siberian fur-traders out of dug-out poplar logs, and eventually the whole party made a raft and floated down the Bei Kem River for 150 miles, shooting a series of rapids about 50 miles above the junction of the Bei Kem and Khua Kem. The party at last arrived at Dja Kul, a small frontier trading centre on the steppes of the Kemchik, where a fresh caravan was made up for the journey across the North-West Mongolian plateau.

The observations on the floral and botanical conditions on this first part of the journey can be divided into two sections, one dealing with the northern slopes of the Sayansk mountains, and the other with the valley of the Bei Kem in the Upper Yenisei plateau.

Taking the first section, I can tabulate the following observations while ascending the Amil River.

After leaving the steppes south of the Minnusinsk district, a thin zone of *Pinus sylvestris* forest appears and forms an intermediate zone between the steppes and the dense sub-arctic forests further to the south. *Pinus sylvestris* attains its best development here, and the ground flora is accompanied by many species of the steppes to the north as well as several species of herbs, which I describe later in the Larch-forest association. South of this zone we reached that of the sub-arctic forest. The dominant species were *Abies sibirica*, *Picea obovata*, and *Pinus sibirica* *. The sub-arctic forest zone lay scattered along the northern side of the different uplifts, which compose the Sayansk system, and varied from 70 to 100 miles in width from north to south. Immense areas of swamp punctuated the dense jungle of Siberian

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* The specimens collected on the expedition are *Pinus Cembra*, Linn., var. *sibirica*, P. Mayr. The variety seems only to differ physiologically from the species.—N. D. SIMPSON.

Spruce and Pine, and everywhere the sub-arctic flora of northern Siberia with *Sphagnum* and *Vaccinium* association was dominant. Progress in this forest from the traveller's point of view was difficult and dangerous.

On the slopes of the valleys with southern aspects the forests of *Abies sibirica* and *Pinus sibirica* appeared to be weaker in growth and were possibly diminishing in area, for considerable forest fires had taken place here in recent years. Where the fires had occurred I saw indications of dry steppe-like flora, containing many types of Gramineæ accompanied by Aspen, Poplar, and Birch, creeping in and competing with the *Vaccinium* association. In addition to this there were certain places where the swamps appeared to be in a state of partial desiccation with evidences of former mossy hummocks, now dry and covered with grasses and species from the steppes further to the north.

The second series of observations were made after entering the Upper Yenisei plateau by a low neck between two disconnected ridges of the Sayansk system. We descended the valley to the Sisti Kem for some distance, but before its junction with the Bei Kem, turned east through the Larch forests and followed up a side stream, called by the natives the "Japsa," to its source in another isolated uplift called the Tashkel mountains. Crossing from here to the watershed of the Shabash River, we followed this down to its junction with the Kamsara River and finally reached the Upper Bei Kem. A further expedition was made towards the head-waters of the Bei Kem in the neighbourhood of Lake Todju Kul, after which a long journey was made in a raft down the Bei Kem, past a series of rapids into the steppes of the Ulu Kem and the Kemchik.

In the upper regions of the Sisti Kem and Shabash Rivers, the valley bottoms of which average about 3000 feet in altitude, we found forests of *Pinus sibirica* accompanied by sub-arctic flora, indicating cold conditions in winter and a considerable rainfall in summer. This forest and association also covered the mountains of the Tashkel. In the lower reaches, averaging 2000 feet in altitude, the forest consisted of *Larix sibirica* scattered in park-like glades with natural meadows. The flora associated with this was of a distinct type and might be called the "Siberian Larch-Forest Association."

In the Larch forest on the Japsa River I found *Gentiana verna* var. *angulosa*, *Vaccinium Vitis-Idæa*, *Spiræa* sp., *Potentilla fruticosa*, and *Erythronium Dens-canis*.

On approaching the Tashkel mountains, forests of *Pinus sibirica* and *Abies sibirica* began to appear on the valley bottoms and reached up to the sides of the mountains to 5000 feet. The ground flora here consisted of *Betula nana*, *Vaccinium Vitis-Idæa*, *Rhodedendron chrysanthum*, *Viola biflora*. In swampy areas there were large beds of *Primula nivalis* and of *Trollius asiaticus* and *Euphorbia lutescens*. There appeared to be a succession of floral types on these Alpine meadows which changed as the summer advanced. Thus

Primula and *Trollius* appeared as soon as the snow had gone, but in July the shady forest association began to creep in and apparently constituted a large portion of the vegetation during the autumn.

On the Upper Shabash River forests of *Pinus sibirica* with a variety of *Alnus Alnobetula* grew in dense jungles on the shady sides of the valley. On the valley sides facing the sun, however, the mountain slopes were covered principally with scrub of Birch, Aspen, and Poplar, accompanied by a vigorous flora of *Euphorbia lutescens*, *Pæonia anomala*, and *Aconitum septentrionale*. Relics of old forests of *Pinus sibirica* and *Abies sibirica* were to be seen in places. Large logs of these trees littered the mountain-sides up to 4000 feet, and there was considerable evidence that the Pine forest had been replaced by a broad-leaved forest within comparatively recent times.

On the Ulug Tag mountain, an isolated peak between the watershed of the Shabash and Japsa Rivers, I observed the following floral zones typical of the Sayansk system, beginning from the valley bottom upwards.

Zone 1. In the valley bottoms at 3000 feet Larch-forest association predominated, containing *Potentilla fruticosa*, *Betula nana*, *Larix sibirica*, and *Erythronium Dens-canis*. *Erythronium Dens-canis* is of considerable interest, since its roots and tubers are used during the summer as food by the nomad tribes of Urian Hai or Soiots, who wander with reindeer all over these forests. The root is dried in the sun, and eaten with reindeer's milk.

Zone 2, at 4000 feet, consisted of thick forests of *Pinus sibirica* and *Picea obovata* accompanied by *Vaccinium Vitis-Idæa* and *Sphagnum*.

Zone 3 began at a height of 4500 feet and consisted of *Pinus sibirica* and *Abies sibirica* in a creeping form.

Zone 4, between 4500 and 5500 feet, consisted of scrub-like *Pinus sibirica* and a widespread distribution of *Rhododendron chrysanthum*.

Zone 5, from 5500 to 8000 feet (the mountain summit), containing only *Betula nana* in a creeping and very stunted form.

Descending the Shabash River from its source, we traversed for a day forests of *Pinus sibirica* with its attending flora. Halfway between its source and its junction with the Bei Kem River, Larch forest with its floral association began. In this typical forest of *Larix sibirica* the trees grew from 10 to 12 feet apart, running from 3 to 6 feet in girth, and averaging about 75 feet in height. The ground flora here was typical of the Larch-forest association throughout the Upper Yenisei plateau and consisted of *Spiræa*, *Euphorbia lutescens*, *Polygonum polymorphum*, *Dracocephalum Ruyschiana*, *Veronica longifolia*, *Bupleurum longifolium* var. *aureum*, *Potentilla nivea*, *Myosotis palustris*, *Achillea impatiens*, *Aster alpinus*, *Galium boreale*, *Valeriana sambucifolia*, *Trifolium Lupinaster*, *Sanguisorba officinale*, *Oxytropis* sp., *Poa altaica*, *Phyllodoce taxifolia*, *Rosa acicularis*, *Vaccinium uliginosum*, *Lonicera cærulea*, *Pedicularis uncinata*, *Aconitum septentrionale*. A few areas of *Pinus sylvestris* were to be seen growing on sandy banks by the river-side. Some of these sandy river-terraces also contained a new and much drier floral association, which began to appear here for the first time. It was represented by *Dianthus versicolor, Caragana Bungei* and *C. arborescens, Sedum hybridum, Thymus Serpyllum, Potentilla bifurca, Agropyron cristatum, Veronica incana.* Higher up the Bei Kem River this steppe-like flora began to enlarge and covered some considerable areas adjoining the river. These areas were largely used as grazing-grounds for the Urian-Hai natives. The steppe-like association here was "sandwiched" in between the Siberian Larch-forest association of the hills and that surrounding the river-banks. There was a large area of this type of steppe association in the neighbourhood of Lake Todju Kul. Descending the Bei Kem River we came to a series of rapids about 50 miles above its junction with the Khua Kem. The plateau valley above the rapids stood at about 2500 feet in altitude and was clothed with dense jungle of *Picea obovata, Larix sibirica*, and *Populus suaveolens.*

The mountains surrounding the gorge of the Bei Kem at this point were ascended by Mr. Carruthers, who observed that the forest of *Pinus sibirica* and *Picea obovata* was not so dense as on the Sayansk mountains. He also observed that the ground was covered with deep half-dry moss, as if it were a sponge which had just run dry. The forest-line here was 5800 feet, and *Pinus sibirica* was the last tree on the forest-line. On the summit there was a flat tableland on which there was very little reindeer-moss but much grass. It seems probable that these mountains in the centre of the Upper Yenisei plateau are intermediate in climate between the Sayansk and the Tannu-ola mountains. The more southern latitude brings less snow in winter than on the Sayansk and proportionately more heat in summer, while the altitudes in both cases are the same.

In the valley of Bei Kem below the gorge, which is also continued in the Ulu Kem further to the west, the valley-sides become gradually barer and the dry steppe-like flora begins to creep in, till at last the forest completely disappears.

It is worth noticing that throughout the upper reaches of the Upper Bei Kem Russian traders and settlers have attempted agriculture. Thus, near the junction of the Shabash and Bei Kem (about 3000 feet alt.), rye was grown in patches by the river. It was impossible to grow wheat on account of the short summer, and sometimes even rye failed to ripen. At a point just above the Bei Kem rapids (2800 feet) both rye and wheat were sown, but rye was the only certain crop. Just below the Bei Kem rapids (2000 feet) we found a fur-trader on the steppe growing wheat to perfection. Here the climate was, if anything, too dry, and it was apparently necessary to irrigate during the summer. Water-melons, cucumbers, apples, and pears were also being grown successfully.

B. NORTH-WEST MONGOLIAN PLATEAU.

General Notes on the Floral Zones.

The principal floral associations of North-West Mongolia can be divided into three groups consisting of the following:—1. Plateau-Desert Association; 2. Larch-Forest Association; 3. Alpine Association. Although many species in these groups overlap, still, in general, each association can be said to occur in definite zones, which vary according to the two principal factors, altitude and latitude. Generally speaking, at northern latitudes and at low altitudes the same flora is found as in more southern latitudes at higher altitudes, but the Larch-Forest Association tends to thin out in southern latitudes, leaving the other two converging. Altitude and latitude are the factors which cause temperature, rainfall, and snowfall, and the degree and intensity of these natural conditions vary in almost exact relationship to the altitude and latitude all over the North-West Mongolian Plateau.

1. The Plateau-Desert Association occurs in all the most low-lying parts of the valley-bottoms, plains, and evaporating basins and all districts where the distance from the mountains is great and consequently the rainfall small or non-existent. Round some of the desert lakes a very thin zone of marsh flora is to be found, growing where saline moisture has reached the surface. With the exception of this and a few straggling patches of Larch forest, the whole of North-West Mongolia between the altitudes of 2000 and 7500 feet is covered with the Plateau-desert association. At the last-named altitude the colder climatic conditions and higher rainfall generally enable either the Larch-forest association or the Alpine association to obtain the upper hand. The Plateau-desert association, however, is broken in a few places between 3000 and 7500 feet, for where special sheltered valleys shade the vegetation from the fierce summer sun, there isolated and straggling patches of the Larch-forest association can be seen. Plateau-desert association is perhaps best studied in North-West Mongolia at an altitude of about 6000 feet. It can be said to be sub-divided into two subordinate associations. The first of these is found more on the shady side of the valleys and in parts of the plains less exposed to cold or drying winds, and is characterised by species of the genus *Caragana*. The second subdivision is found in the driest, hottest, and most exposed plateau desert, and is the most widely distributed. The most characteristic species of the latter are:—*Potentilla sericea*, *Arenaria capillaris*, *Chenopodium frutescens*, var., *Stipa capillata*, *Artemisia argyrœfolia*, *Oxytropis tragacanthoides*.

2. The Larch-Forest Association is found scattered wherever conditions are suitable between certain altitudes. Thus in the Kemchik valley on the Upper Yenisei plateau, Larch forest is found on scattered areas between 3000 and 6000 feet. Some 80 miles to the south, in the Saklya valley on

the west of Lake Ubsa, the Larch forest occurs between 6000 and 7000 feet. Some 40 miles to the south of this again, on the Kundelun mountains, the Larch forest occurs between 6300 and 7600 feet, while on the right bank of the Upper Kobdo River and round the Kobdo Lakes, the Larch-forest zone occurs between 7000 and 8000 feet. Thus the zone gradually rises in altitude as the southern latitudes are reached. But in the case of the Larch-forest association, latitude and altitude are not the only factors which control its distribution, for it appears that shelter from insolation, and perhaps wind, is a third factor to be taken into consideration. This is suggested from the fact that the Larch-forest association all over the North-West Mongolian plateau is found only on that side of the valley which has a northern aspect, while it reaches its best development in the shady glens of the mountains. Moreover, the complete absence of any Larch forest in the country between Achit Nor and the Kobdo River seems to suggest that a large area of open down country, even though it may be at a favourable altitude and latitude, if too exposed to wind and snow, is unfavourable for the development of Larch-forest association. In this area, therefore, which is drained by the left tributaries of the Kobdo River, namely, the Suok, the Taharty, the Olonor, and the Tsagangol Rivers, the Plateau-desert association merges into the Alpine association without any intermediate Larch-forest association. The following are its most characteristic species:—*Larix sibirica*, *Vaccinium Vitis-Idæa*, *Aconitum* sp., *Potentilla bifurca*. *Pinus sibirica* also occurs in this association in the extreme north, and is found as a straggling specimen as far south as the western Tannu-ola mountains, where it reaches the summit. It appears that the excess of sun and light is responsible for its absence in latitudes further south of this.

3. The Alpine Association is distributed in North-West Mongolia in the following areas:—In the Kemchik valley of the Upper Yenisei plateau it is found on several isolated mountain masses between 6000 and 6500 feet. On the Kundelun mountains it begins at an altitude of 7000 feet, and further south still, on the right bank of the Kobdo River, it commences at 8000 feet. It reaches the snow-line at about 11,000 feet in the last two places, wherever there is sufficient soil. The best development of the Alpine association is found on the left tributaries of the Upper Kobdo River, namely, on the Suok, the Taharty, the Olonor, and Tsagangol Rivers. Here a large area of rolling down country between 8000 and 10,000 feet alt. is the geographical feature, and is peculiarly favourable for the development of this flora. It is interesting to know that it is just here that *Ovis ammon*, the great mountain sheep of the Altai, is found in considerable numbers, and its distribution seems to coincide with the widespread distribution of the Alpine association. The characteristic species of the Alpine meadows of North-West Mongolia are:—*Gentiana altaica*, *Gentiana prostrata*, *Saxifraga Hirculus*, *Primula nivalis*, *Trollius asiaticus*, *Papaver nudicaule*, *Betula nana*.

Itinerary of the Expedition on the N.W. Mongolian Plateau.

The Kemchik River is a left tributary of the Upper Yenisei, joining the Ulu Kem just above the gorge, through which it flows to the lowlands of Siberia. The valley of the Kemchik was visited by the expedition during July 1910. Starting from Dja Kul, a frontier trading post (1880 feet) on the Ulu Kem River, the route lay westwards along the Kemchik for 50 miles. Here the mountain mass of the Kizil Taiga was visited, after which the Kemchik valley was crossed south-west to the Tannu-ola mountains.

The plains of the valley bottom on the Kemchik were covered with Plateau-desert association. On alluvial soil were found *Caragana spinosa*, *Urtica dioica*, *Elymus dasystachys*. On northern slopes and in sheltered hollows, patches of the Larch-forest association were to be seen, accompanied by *Potentilla bifurca* and *Aconitum barbatum*.

The mountain mass of the Kizil Taiga, which lay in the centre of the drainage area of the Kemchik, was surrounded by plateau-desert flora up to about 4000 feet. At this point Larch forest commenced in shady places and continued nearly up to the summit. *Pinus sibirica* was found in conjunction with *Larix sibirica*. The former slightly predominated on rocky ground, and the latter in those aspects more open and exposed to the sun. Natural regeneration of both these species was going on, but the Larch appeared to be badly affected by summer frosts. About the forest-line there was a considerable area covered with dead logs of Larch trees, larger than any growing at present below this line. It seemed that the forest at one time extended much higher up the mountain than at the present. The flora of the barren mountain tops (6500 feet) contains a mixture of both Alpine meadow and Larch-forest association apparently in competition with one another. The Larch-forest association was represented by *Potentilla bifurca*, *Spiræa* *Vaccinium uliginosum*, *Aconitum* sp., and *Veratrum nigrum*. The Alpine association was represented by *Betula nana*, *Gentiana prostrata*, and *Dryas octopetala*. There was a considerable amount also of *Poa* and Fescue grasses mixed in with these floras. In fact it seemed that two floral associations distinctly joined on the summit of the Kizil Taiga.

Leaving the Yenisei basin by a right tributary of the Kemchik, the expedition crossed the Tannu-ola mountains into the plateau which drains into Lake Ubsa. The Tannu-ola mountains form a watershed between the inland drainage of North-West Mongolia and the Arctic drainage of Siberia. In its western end it presents a solid range of rolling downs and is crossed by several passes. The Bovashay Pass, crossed by the expedition at 6854 feet, was covered with forests of stunted Larch and Siberian Pine scattered about in open order, with much dead timber. *Pinus sibirica* was, in the main, dominant, with floral representatives from the Larch-forest association and a few Alpine meadow types. On a peak overlooking the Bovashay Pass, reindeer-moss, *Sphagnum*, *Vaccinium uliginosum*, *Potentilla bifurca*, and

Aconitum sp. were found. This flora continued all the way to the summit. At 6500 feet *Rosa spinosissima* was seen. Both Larch and Siberian Pine reached the summit in a creeping form, and there were many places where dead logs of trees were lying.

The southern slopes of the Tannu-ola mountains between the Mongol guard posts of "Borgitaita" and "Bogdhonholat" were bare, and covered with plateau-desert flora. There were two distinct subdivisions of this association here, one of which was characterised by *Caragana arborescens* and *Cotoneaster melanocarpa.* The other subdivision lay in those parts more exposed to the sun, and was represented by *Potentilla sericea, Spiræa hypericifolia, Arenaria capillaris, Stipa capillata, Oxytropis tragacanthoides, Chenopodium frutescens, Anemone Bungeana.*

The North-West Mongolian plateau between the Tannu-ola mountains and the Great or Chinese Altai range presents a large tableland stretching north and south some 300 miles and averaging some 5000 feet in altitude. Both of these ranges of mountains converge westwards into the complex Siberian Altai system. The level of the plateau is lowest round the evaporating basins, and at Lake Ubsa sinks to 2270 feet, while at Achit Nor it is about 4000 feet. There are many lofty ranges and disjointed mountain masses on this plateau running up to 13,000 feet. The first of these ranges, which the expedition came to after crossing the Tannu-ola mountains, ran from north-west to south-east, and joined the western extremity of the Tannu-ola near the point where it converged into the Siberian Altai system. The river draining from this range into Lake Ubsa was called by the natives the Saklya River, and hence the name of Saklya mountains was given to the range from which it sprang. It was found that the floral association of the plateau-desert in the valley of the Saklya River, between 4000 and 6500 feet, contained plateau-desert type represented by *Artemisia argyræfolia, Anemone Regeliana, Arenaria capillaris,* and *Caragana spinosa.* Between 6000 and 7500 feet there were patches of Larch forest with its accompanying association, represented by *Aconitum* sp. and *Spiræa.* From 7300 to 9000 feet there was a large development of Alpine meadow with scattered peat-bogs. The characteristic flora here was represented by *Eriophorum Scheuchzeri, Dracocephalum imberbe, Epilobium hirsutum, Saxifraga melaleuca, Potentilla nivea, Erigeron uniflorus, Cerastium lithospermifolium, Carex melanantha, Senecio aurantiacus, Myosotis sylvatica, Pedicularis versicolor, Primula nivalis.*

Crossing from the Saklya River into the valley of the Kundelun, which is also a western tributary of Lake Ubsa, the expedition traversed stony desert-plateau lying between 5500 and 6500 feet. All the way there was almost a complete absence of vegetation, and the only species met with were *Stipa capillata* and *Agropyron cristatum.* In some places only dry stems of *Stipa capillata* were seen, showing that the herb had grown earlier in the season, but in summer was shrivelled by heat. There were evidences in the torrent beds of occasional cloud-bursts, but the whole country was waterless and without springs.

Ascending the Kundelun River, a great mountain mass was observed rising to 13,000 feet with many glaciers and snowfields. This system, which the expedition named the Kundelun mountains, is probably the one mentioned by Potanin, who visited its eastern side and called them the Turgun mountains. At "Kunde Kureen," the seat of a Mongol prince, altitude 5900 feet, the flora was of the plateau-desert type containing *Arenaria capillaris* var. *nardifolia* and *Stipa capillata.* At 6300 feet Larch forest commenced in shady places accompanied by *Aconitum* sp. The forest continued up to 7600 feet on the shady side of the valleys only. At 7000 feet the Alpine association began to creep in with *Gentiana prostrata.* At this height good grazing-land was found in the bottoms of the valleys, and the Mongol population grazed their flocks here during the latter part of the summer. Between 7500 and 7600 feet there is an area of dry peat-beds containing old tufts, upon which grass is now growing. Above this there was an area of bog and swamp. There were some indications that the swamps once extended lower down the valley, and that the drier floral association is extending over the area once covered by Alpine meadow. At 8300 feet the expedition came upon the Kundelun glaciers, which descend from the snowfield between 11,000 and 13,000 feet. There were some evidences that these glaciers were retreating, for several recently evacuated moraines were to be seen, upon which vegetation of *Sphagnum*, *Allardia glabra*, and *Sedum quadrifidum* were beginning to appear. In the little glacial lakes *Sphagnum* and *Ranunculus natans* were obtained. Vegetation continued up to 11,000 feet, which can be taken as the line of the summer snow. The specimens found at this altitude were *Allardia glabra* and *Sedum quadrifidum.*

After leaving the Kundelun mountains the expedition visited the basin of Lake Uriu Nor, and, crossing the Barmen mountains to the south, reached the watershed of the Upper Kobdo River. Round Lake Uriu Nor (height 4500 feet) there was a peculiar type of flora, which was found right on the edge of the lake, growing in the marshes and stagnant pools. It was represented by *Artemisia Sieversiana, Nepeta botryoides*, *Anabasis brevifolia*, and *Ranunculus Cymbalaria.* There was evidence that the lake had once been at a higher level, for strands of gravel lay at from ten to thirty feet above the present water-level. The lake had no outlet, and therefore indicates in its water-level any variation in the climatic conditions of this part of North-West Mongolia.

On the Barmen mountains, 8200 feet, south of Lake Uriu Nor, Alpine meadows with *Betula nana* were discovered. Larch forest was seen in shady places at about 7500 feet. This is also the height above which late summer and early autumn snow falls. It is probable that the latter determined the limit of the Larch forest.

South of the Barmen mountains on the plains of Achit Nor (4500 feet), which drains into the Upper Kobdo River, concentric rings of vegetation were to be observed. In the marshes and shallow lagoons immediately round the lake were to be seen *Glaux maritima*, *Chenopodium glaucum*, *Suæda maritima*, *Triglochin palustre*, *Juncus Gerardi*, and *Agrostis vulgaris*. Beyond the marshes on moist, sandy loam, where vegetation was just above the water-table, the following flora was seen: *Salicornia herbacea*, *Carex cæspitosa*, *Carex capillaris*, *Hordeum pratense*, and *Iris ensata*. On the stony desert, out of reach of the water-table, were found representatives of the Plateau-desert association, particularly *Stipa capillata*.

Leaving the plain of Achit Nor and ascending the Kobdo River by its affluent tributary the Suok River, the expedition crossed the tableland, averaging 5000 feet alt. and rising in rolling downs to 8000 feet. After crossing the Suok valley, those of the Taharty, Olonor, and Tsagangol were each traversed in turn, till finally, the Kobdo Lakes were reached.

Between 7000 and 8000 feet the rolling downs were covered with vegetation of the Plateau-desert association, represented by *Oxytropis tragacanthoides*, *Artemisia argyræfolia*, *Stipa capillata*, *Chenopodium frutescens*, *Tanacetum fruticulosum*, *Elymus dasystachys*, *Allium fistulosum*. At 8000 feet Alpine association began to take the place of Plateau-desert association. On that part of the valley with northern and shady aspects this type consisted largely of *Polygonum Bistorta*, *P. viviparum*, and *Betula nana*. In the upper part of the Alpine meadows, between 8300 and 9000 feet, the Alpine association was spread out over a large area of rolling downs in the Upper Olonor valley. The characteristic species here were *Papaver nudicaule*, *Saxifraga Hirculus*, and *Gentiana prostrata*.

On reaching the Kobdo Lakes, which lie just to the north of the Great Altai range, the Plateau-desert association was found between 6300 and 7500 feet, represented by *Stipa capillata*, *Oxytropis tragacanthoides*, *Chenopodium frutescens*. Round the Kobdo Lakes, at 7000 feet, Larch forest again was to be seen in shady places all over the northern slopes of the Great Altai range. The Larch forest contained *Betula nana*, *Potentilla bifurca*, and reached to the height of 8500 feet. Between 8000 and 9000 feet there was a large development of Alpine meadow which reached to 9500 feet. The expedition crossed the Great or Chinese Altai mountains by the Urkhogaitu Pass, 9500 feet, and following the valley of the Kran River on the south side of the range, reached the plains of the Upper or Black Irtish in Dzungaria. On the Kran River there was a considerable development of Siberian Larch forest between 3000 and 6700 feet in shady places, accompanied by *Aconitum* sp., *Spiræa*, *Vaccinium Vitis-Idæa*, *Rosa acicularis*, *Rosa spinosissima*, *Sambucus racemosa*, *Thalictrum petaloideum*, *Lonicera cærulea*, *Cotoneaster melanocarpa*, *Berberis heteropoda*, *Althæa rosea*, and *Potentilla chrysantha*.

C. DZUNGARIA.

Itinerary and General Notes.

South of the North-West Mongolian plateau lies an area of comparative lowland, bounded on the north by the wall of the Great or Chinese Altai, and on the south by the main range of Tian Shan. The average altitude of the plain is about 1500 feet, the highest point being 4000 feet and lowest about 700 feet above the level of the sea. The area is drained in the south by rivers which flow into small evaporating basins, while most of the north is drained by the Upper or Black Irtish and finds its way ultimately to the Arctic. Towards the north-west, therefore, these plains of Dzungaria merge without any perceptible break into the lowlands of Western Siberia. There are, however, three ranges, namely, the Ala Tau, Barlik, and Sair mountains, which cross the plain from north-east to south-west, but which are disjointed and severed by intervening pieces of lowland, so that they do not form an effective barrier to the drainage northward. Eastwards the steppes merge into the Gobi Desert of Central China. The Great Altai range, which bounds the Dzungarian plains on the north, runs south-eastwards towards the main range of the Tian Shan, which, in turn, runs east and west. A gap of over 100 miles separates the eastern extremities of these ranges, and thus the plains of Dzungaria pass into the plains of Central China without a break through this gap.

Descending from the North-West Mongolian plateau and crossing the Great Altai range, the expedition reached the Chinese town of "Sharasume," or "Tulta," in Sept. 1910, on the southern foothills of the Great Altai mountains. The plains of the Black Irtish were then crossed, leaving Lake Ulun-gur to the east and reaching the valley of Kobuk. Here the southern offshoot of the Sair mountains was crossed, which is one of the disjointed ranges traversing the Dzungarian plain. Ultimately the Chinese town of "Chuguchak," or "Tarbagatai," was reached on the plains of the Emil, whence the route lay direct south to Kuldja, through the Dzungarian gap and over the Tian Shan.

The floral associations of Dzungaria do not differ widely from those of the North-West Mongolian plateau. During the journey a large number of species were met with common to both districts, but it was found on proceeding southwards that several new species began gradually to creep in. The more southern latitudes, which are exposed to drought and fierce heat of the sun in summer, create conditions favourable for the driest desert floral association.

After leaving the town of "Sharasume," an area of rugged, stony hills was traversed, covered with desert floral association, which was in every way typical of those described in North-West Mongolia. Thus the following species were collected in considerable abundance:—*Artemisia Lercheana*, *Atraphaxis lanceolata, Echinops Ritro, Potentilla Anserina, Leonurus lanatus.* The following new types were seen for the first time in their apparently most northerly limit:—*Setaria viridis, Cannabis sativa, Halimodendron argenteum, Haloxylon Ammodendron,* and *Astragalus Pallasii.*

Proceeding southwards, the hills, which lay between 1700 and 2300 feet, were replaced by a plain, which lay between 1500 and 1700 feet. The plain was largely alluvial, with some patches of blown sand near the Black Irtish River. As the river meandered north-westwards it was covered with breaks of Poplar and Willow. On the alluvial desert there appeared *Halimodendron argenteum, Sophora alopecuroides, Glycyrrhiza uralensis, Eurotia ceratoides,* var., *Artemisia Lercheana, Elymus giganteus,* and *Tamarix* sp. Leaving this low-lying plain and proceeding southwards the altitude rose to a plateau, which lay to the north-east of the Sair mountains. This range, which runs roughly east and west, joins on to the offshoots of the Tarbagatai and Barlik mountains and forms part of the disjointed range which runs across Dzungaria from south-west to north-east. The plateau to the south of the Sair mountains, which was drained by the Kobuk River, lay between 2000 and 5000 feet. On it were found *Anemone Bungeana* (the same as in North-West Mongolia), *Anemone patens, Iris ensata, Artemisia Lercheana,* and *Spiræa hypericifolia.* On rising to 5500 feet on a pass connecting a southern offshoot of the Sair mountains with a northern offshoot of the Barlik, small patches of *Larix sibirica* were seen in places sheltered from the sun. With it were also the accompanying flora, characteristic of Southern Siberia and North-West Mongolia, namely, *Aconitum* sp., *Potentilla bifurca* var. *canescens, Rosa spinosissima, Anemone Bungeana,* and *Juniperus pseudo-sabina.*

Descending to the plain of the River Emil, which flows westwards into Lake Ala Kul, the altitude was found to lie between 1600 and 2500 feet and largely consisted of alluvium. In the highest and driest parts of the plain *Artemisia Lercheana, Stipa capillata,* and *Anemone patens* were predominant; while in the lower parts nearer the water-table the following species predominated: *Glycyrrhiza uralensis* and *Elymus dasystachys.*

South of the plain of the Emil and on the northern slopes of the Barlik mountains were found the most northerly specimens of *Picea Schrenkiana,* accompanied by an association partly characteristic of the Larch forest of North-West Mongolia, but containing also many new species. Unfortunately the expedition reached this point too late in the year to obtain representative specimens of the flora, for the snow had already begun to cover the altitudes which lay between 5000 and 6000 feet. It was observed, however, that the most southerly limit of *Larix sibirica* was on the southern slopes of the Sair mountains, while the most northerly limit of *Picea Schrenkiana* lay on the northern side of the Barlik mountains. Crossing the Ala Tau mountains on the way to Kuldja and the Ili, large forests of *Picea Schrenkiana* were observed rising to an altitude of over 9000 feet, but the snow was too deep to enable any investigation of the ground flora to be made.

II.

ENUMERATION OF THE PLANTS.

BY N. D. SIMPSON.

DICOTYLEDONES.

RANUNCULACEÆ.

CLEMATIS ÆTHUSIFOLIA, *Turcz.*

No. 489. In sheltered gullies with northerly aspect, chiefly associated with stunted Larch forest, in the Northern foothills of the Tannu-ola Mts. between Dja Kul and Djardan.

Distribution. Mongolia, N. China, and Manchuria.

CLEMATIS ALPINA, *Mill.*, var. SIBIRICA, *Regel et Til.*

No. 291. Moist forest glades near rivers, climbing dead stumps or on basalt rocks, S.E. of Kushabar on the Amil River.

Distribution. Siberia and N. Russia.

THALICTRUM PETALOIDEUM, *Linn.*

No. 427. Driest parts of open steppe between the flood-line of the river and the Larch-forest zone, Upper Bei Kem and Dora Kem.

Distribution. Siberia, Manchuria, and N. China, *Lecoyer.*

THALICTRUM MINUS, *Linn.*, var. ELATUM, *Lecoyer.*

No. 372. Dry slopes up to 900 m., Kushabar Range of the Sayansk Mts.

Distribution. Europe, Asia Minor eastwards through Siberia to Japan, *Lecoyer.*

ANEMONE BUNGEANA, *Pritz.*

No. 17. Dry mountain summits where not too rocky, Kizil Taiga, Lower Kemchik.

No. 32. Dry desert hill-slopes and upland plateau valleys up to 2150 m., W. Tannu-ola Mts.

Distribution. N. Mongolia and Altai.

ANEMONE REGELIANA, *Maxim.*

No. 68. Plateau valleys up to 2150 m., Upper Saklya River, W. Tannu-ola Mts.

Distribution. Siberia, Turkestan, N. Mongolia, and China.

ANEMONE sp. (§ Pulsatilla).
No. 1. Hilly steppe 270 m. near Borodina.

ANEMONE PATENS, *Linn.*
No. 3. Steppe, Minnusinsk, Siberia.
Distribution. Central Europe, Mongolia, Turkestan, and N. America.

ANEMONE PATENS, *Linn.*, var. NUTTALLIANA, *A. Gray*, flore ochroleuco.
No. 267. Edges of cultivated land with Birch and grasses on dry banks, Kushabar.
Distribution. N. Mongolia and N. America.

ANEMONE ALTAICA, *Fisch.*
No. 259 *a.* Damp hollows in the "Taiga" or forest under the shade of *Abies sibirica* and *Populus suaveolens* associated with grasses ; alt. above the sea 320 m., in forests round Kushabar, Amil River.
No. 321 *a.* 1000 m. in Spruce Taiga, growing under melting snow, Chukuok Ridge, Amil River.
Distribution. Altai, N. China, and Japan.

ANEMONE BAICALENSIS, *Turcz.*
No. 278. Shade of Birch, Pine, Spruce, and Poplar forest where not too marshy ; very common and universal forest-shade plant, Kushabar.
Distribution. N. and central China, Manchuria, and westwards to the Yenisei.

ANEMONE CÆRULEA, *DC.*
No. 326. Moist places near rivers and streams and in moist glades of the Spruce forest, Upper Amil River.
Distribution. Central Asia and Altai, N.E. Siberia and Japan.

ANEMONE RANUNCULOIDES, *Linn.*
Distribution. Europe and eastwards as far as the Baikal region.

ANEMONE REFLEXA, *Steph.*
No. 257 *a.* Pine, Birch, Poplar, and Spruce Taiga, in shade, forests round Kushabar, Amil River.
Distribution. Siberia from the River Irtish eastwards to Kamtchatka.

CALLIANTHEMUM RUTÆFOLIUM, *C. A. Mey.*
No. 340. Moist meadows near rivers, also in alpine meadows in the Upper Pine forest, Sistikem and Japsa Rivers.
Distribution. Southern Europe eastwards through central Asia, Turkestan to Yunnan.

RANUNCULUS AFFINIS, *R. Br.*, var. β. TANGUTICUS, *Maxim.*, forma DASYCARPUS.

No. 65. Upland plateau valleys on dry slopes at about 2150 m. on the W. Tannu-ola Mts. at the head of the Saklya River.

Distribution (of var.). Kansu and N. Thibet, *Maxim.*

RANUNCULUS ALTAICUS, *Laxm.*

No. 379. Mountain-summits on dry patches and among rocky boulders, alt. 1800 m., Ulug Taiga, Sayansk Mts., Upper Japsa Mts.

Distribution. Turkestan eastwards to the Behring Straits, and in China.

RANUNCULUS CYMBALARIA, *Pursh.*

No. 91. Marshes and lagoons on the dry side of desert lakes and on lake shores where submerged in spring, Uriu Nor and Achit Nor.

Distribution. Altai, Tian Shan, and Arctic Siberia.

RANUNCULUS PROPINQUUS, *C. A. Mey.*

No. 328. Sandy gravel of the dry rivers near the Upper Amil River.

Distribution. Southern Siberia and Altai.

RANUNCULUS NATANS, *C. A. Mey.*, spec. sterilia.

No. 80. Small shallow lakes at the foot of Kundelun glaciers with *Sphagnum* and *Eriophorum.*

Distribution. N.W. Mongolia, Baikal region, and North America.

RANUNCULUS RADICANS, *C. A. Mey.*

No. 407. Sandy banks on edges of rivers, Lower Kamsara River.

Distribution. Southern Siberia, Altai, and N. China.

RANUNCULUS SCELERATUS, *Linn.*

No. 438. Swamps at the margin of Lake Todju Kul.

Distribution. Europe eastwards to the Loo Choo Islands, southwards to Annam and in N. Africa.

RANUNCULUS SPHÆROSPERMUS, *Boiss. et Blanch.*

No. 105. In marshes and lagoons by the sides of desert lakes, Achit Nor, and mountain lakes on the Yamartu Plateau.

Distribution. Morocco, Mesopotamia, and Persia.

TROLLIUS ASIATICUS, *Linn.*

No. 265 *a.* On the edges of cultivated land and Pine forest shade, Kushabar.

Distribution. The Altai and Ala Tau Mts. eastwards to Manchuria.

TROLLIUS CHINENSIS, *Bunge*?

No. 262 *a*. Moist places where not water-logged, Kushabar and up the Amil River.

This plant according to the keys should be *T. chinensis*, Bunge, but it differs from that plant, however, in having its style passing gradually into the carpel and not abruptly springing from it. This specimen agrees in detail with a cultivated specimen from the garden of M. Vilmorin in Herb. Gay.

AQUILEGIA VULGARIS, *Linn.*

No. 334. On rocky mountain slopes at 1600 m. in the crevices of boulders, also on the upper valley steppe, Sayansk Mts., White Mt., and Upper Japsa Valley.

It is identical with Wilson's specimen no. 1331, Herb. Kew.

Distribution. Through Europe eastwards to China.

DELPHINIUM MAACKIANUM, *Regel.*

No. 25. Dry parts of valley bottoms and often with *Larix* shade association, Kindergay Valley and Tulu in the N. Tannu-ola Mts.

Distribution. Manchuria.

ACONITUM AMBIGUUM, *Reichb.*?

No. 500. High upland meadows where the soil is dry peat, at 1500 m., Lower Kemchik, Kizil Taiga, and shores of Sul Kul.

This plant is *Aconitum Napellus*, Linn., var. *β. alpinum*, lusus a. *ambiguum*, Regel, from Siberia altaica leg. Mardovkin, in the Kew Herbarium. It is near *A. ambiguum*, Reichb., but the hood is more curved. It is an undescribed species, but the material is insufficient for description.

ACONITUM SEPTENTRIONALE, *Köll.*

No. 371. Dry slopes of mountains up to 900 m., in the Kandart Range, Sayansk Mts.

Distribution. Europe: Norway, Sweden and Russia. Asia: China and Japan.

ACONITUM BARBATUM, *Patrin.*

No. 485. Shade of Larch forests in shaded valley bottoms and on northern slopes, Northern foothills of Tannu-ola Mts. between Dja Kul and Djardan River.

Distribution. Irkutsk district, Manchuria, and China.

ACTÆA SPICATA, *Linn.*

No. 304. Shade of Spruce forest, Amil River.

Distribution. Europe, Siberia, Baikal region, Ussuri, China, and Japan.

PÆONIA ANOMALA, *Linn.*, forma capsulis glabris.

No. 293. Poplar and Spruce forests in open glades up to 600 m., Amil River.

Distribution. Caucasus Mts., Baikal region, and Turkestan.

BERBERIDEÆ.

BERBERIS HETEROPODA, *Schrenk.*

No. 139. Southern aspects, 900 m. to 1500 m., Southern Great Altai, Upper Kran River in the basin of Black Irtish.

Distribution. Mongolia and Eastern Turkestan.

BERBERIS SIBIRICA, *Pall.*

No. 335. Crevices of rocks at 1600 m., White Mountain in the Sayansk Mountains.

Distribution. Dzungaria eastwards to Manchuria.

NYMPHÆACEÆ.

NYMPHÆA TETRAGONA, *Georgi.*

No. 439. Todju Kul lake, near the margin in about 1 m. of water.

Distribution. Eastern Europe, Asia, and N. America, *Conard.*

PAPAVERACEÆ.

PAPAVER NUDICAULE, *Linn.*, subsp. MICROCARPUM, *Fedde.*

No. 380 *a.* On the summit of the Ulug Taiga on dry patches amongst rocky boulders at altitudes over 2300 m.

Distribution (of subsp.). Arctic and sub-arctic Asia, *Fedde.*

Subsp. XANTHOPETALUM, *Fedde.*

No. 380 *b.* The same habitat and locality.

Distribution (of subsp.). Central Asia, throughout Siberia and in N. China, *Fedde.*

CHELIDONIUM MAJUS, *Linn.*

No. 316. Moist open places in forests or Taiga on the Amil River.

Distribution. Europe, Asia, N. America, and N. Africa southwards to Teneriffe.

CORYDALIS BRACTEATA, *Pers.*

No. 255. Moist peaty loam near the bank of the Amil River under shade of *Salix Capræa* bushes. About 100 miles S.E. of Minnusinsk near the village of Kushabar.

Distribution. Yenisei and Altai Mts.

CORYDALIS SOLIDA, *Sw.*
Kushabar, Minnusinsk Division.
Distribution. Central Europe, Asia Minor, throughout Turkestan and Mongolia, Manchuria, Korea, Northern China, and in Japan.

CRUCIFERÆ.

NASTURTIUM PALUSTRE, *DC.*
No. 435. Swamps at the edge of Todju Kul.
No. 446. On dry sandy banks by the River Bei Kem, under the floodmark, so only growing in midsummer.
Distribution. Europe, Asia, N. Africa, N. and S. America.

ARABIS INCARNATA, *Pall.*
No. 434. Dry steppe near the Upper Bei Kem.
Distribution. Asia Minor, Southern Siberia, and the Altai.

ALYSSUM FISCHERIANUM, *DC.* ex descript.
No. 480. On very dry rocky slopes in an almost desert flora, Ulu Kem, Dja Kul.
Distribution. Dahuria.
This specimen is the same plant as the specimen in Herb. Kew. "*A. lenense*, Adams. No. 411. Plantæ Dahuricæ, leg. Karo."

DRABA NEMORALIS, *Linn.*, var. α. BREVIPES, *DC.*
No. 342 *a*. Dry banks in the Sistikem Valley, in the moist *Larix* association, Vrianhai country.

Var. NEMORALIS, *Ehrh.* (pro specie).
No. 342 *b*.
Distribution. Europe, N. America, Turkestan, and the Altai eastwards to Manchuria.

CARDAMINE PRATENSIS, *Linn.*, forma C. PARVIFOLIA, *Wimm. et Grab.*
No. 273. Edges of swamps associated with scrub Birch and *Caltha*, Kushabar.
Distribution. Western Siberia, *O. Schultz.*

HESPERIS MATRONALIS, *Linn.*, var. γ. SIBIRICA, *DC.*
Found near Kriloff.
Distribution. Altai.

SMELOWSKIA CALYCINA, *C. A. Mey.*
No. 118 *a*. Stony desert on hill-sides and in plateau valleys up to 2450 m.

under the driest vegetative conditions; southern Tannu-ola Mts., Achit Nor basin, Suok Valley, and on the N. side of the Altai Mts.

Distribution. N. Mongolia, Altai, and the Rocky Mts. of N. America.

ERYSIMUM ALTAICUM, *C. A. Mey.*, var. γ. HUMILLIMUM, *Ledeb.*

No. 33. Dry desert hill-slopes and upland valley plateaus up to 2150 m., Bodhon Valley, W. Tannu-ola Mts.

Distribution (of variety). North and West Mongolia and Dahuria.

ERYSIMUM CHEIRANTHOIDES, *Linn.*

Distribution. Europe, N. Asia, and N. America.

LEPIDIUM LATIFOLIUM, *Linn.*, var. AFFINE, *C. A. Mey.*

No. 494. Driest hill-slopes and valley-bottoms, sandy and gravelly places, Dja Kul and Djardan valleys.

Distribution. N. and E. Mongolia, and China.

RAPHANUS SATIVUS, *Linn.*

No. 42. Cultivated in Chinese gardens, the root is eaten, Bogdo-ola.

Distribution. Wherever there is cultivation.

VIOLACEÆ.

VIOLA ALTAICA, *Pall.*

No. 337. Rocky places on the White Mountain, Sayansk Mts., 1800 m.; also in meadows near rivers on well-drained land, Argaiak River.

No. 365, flore albo. Marshy meadows up to 1200 m. (mid-season growth), Upper Japsa, Shabash, and Kandart systems.

Distribution. Asia Minor, Turkestan, southern Siberia, and the Altai.

VIOLA BIFLORA, *Linn.*

No. 360. Dry mountain summits, Sayansk Mts., Upper Kandart and Japsa systems.

Distribution. Europe, Turkestan, N.W. Mongolia, Kamtchatka, China and Japan, extending southwards into northern Thibet.

VIOLA CANINA, *Linn.*

No. 266. Edges of cultivated land and shade of forests, Kushabar

Distribution. Northern temperate regions, extending southwards to Kashmir and N. India.

VIOLA UNIFLORA, *Linn.*

No. 262 *b*. Sayansk Mts. in Upper Kandart and Japsa systems.

This is the typical plant as figured in Gmelin's 'Flora Sibirica,' tab. 48. fig. 5.

Distribution. Western and southern Siberia and northern Mongolia.

POLYGALACEÆ.

POLYGALA VULGARIS, *Linn.*

No. 288. Dry banks under shade of Pine and Birch, in forests round Kushabar; and barren and dry hill-slopes, Kemchik basin, Tannu-ola Mts.

Distribution. Europe, Asia Minor, southern Siberia, and Altai, *Chodat.*

CARYOPHYLLACEÆ.

DIANTHUS SUPERBUS, *Linn.*

No. 451. Larch association type, Sabieff, Lower Bei Kem.

Distribution. Europe, south and east; Asia, in Mongolia, China, and Thibet, *F. N. Williams.*

DIANTHUS VERSICOLOR, *Fisch.*

No. 413. River-terraces and desert parts of open steppe between flood-line of rivers and the Larch-forest zone, Kamsara and Bei Kem Rivers.

No. 447. On dry sandy banks by the River Bei Kem, under flood-mark, so only growing in midsummer.

Distribution. Mongolia and Dahuria, *F. N. Williams.*

GYPSOPHILA DESERTORUM, *Fenzl.*

No. 481. Very dry rocky hill-slopes, almost desert flora, Dja Kul, Ulu Kem.

Distribution. N. and N.W. Mongolia.

SILENE REPENS, *Patrin.*

No. 443. On dry sandy banks by the River Bei Kem, under flood-mark, so only growing in summer.

Distribution. Russia, Siberia, Mongolia, Manchuria, China and Japan, *Rohrbach.*

LYCHNIS SIBIRICA, *Linn.*

No. 405. Driest floral type of open steppe in valley-bottoms or on a dry river terrace, Upper Bei Kem.

Distribution. Baikal region, Dahuria, and Amur province.

STELLARIA DICHOTOMA, *Linn.*, var. β. HETEROPHYLLA, *Ledeb.*

No. 450. Larch association type, Sabieff, Lower Bei Kem.

Distribution. Turkestan, N. Mongolia, and Baikal region.

STELLARIA NEMORUM, *Linn.*

No. 300. Shade of Spruce, Birch and Poplar forests, very common and universal, Amil River.

Distribution. Europe.

This appears to be the true European species.

CERASTIUM DAVURICUM, *Fisch.*

No. 124. Southern aspects of the Great Altai, Upper Kran River, in the basin of Black Irtish, 900 to 1700 m.

Distribution. Turkestan and Mongolia; Siberia from the Caucasus to the Amur River, extending southwards to Kashmir and N.W. India.

CERASTIUM LITHOSPERMIFOLIUM, *Fisch.*

No. 57. Dry shady slopes where some soil has accumulated, mountain-sides 2600 m., Tannu-ola Mts., head of Saklya River.

Distribution. Turkestan and N. Mongolia.

ARENARIA sp. nov.?

No. 375. Highest mountain-tops 1950 m., also open steppe valley-bottoms with dry flora, range of Sayansk Mts., steppes of Shabash Valley, Kamsara River.

ARENARIA CAPILLARIS, *Poir.*, ε. FORMOSA, *Fisch.*, lusus a. ALPINUS, *Regel.*

No. 36. Dry desert hill-slopes and upland valley plateaus up to 2100 m., Bodhon Valley, W. Tannu-ola Mts.

ARENARIA CAPILLARIS, *Poir.*, ζ. NARDIFOLIA, *Ledeb.*

No. 55. Dry valley bottoms, rocky hill-slopes and desert flora 1200 to 2750 m., in alpine meadows on mountain-sides, W. Tannu-ola Mts.

Distribution (of species). The Ural Mts. eastward to British Columbia and Western United States and extending northwards into the Arctic Circle, *F. N. Williams.*

TAMARISCINEÆ.

TAMARIX sp.

No. 164. Alluvial and sandy plains at 760 m. and under. Medium dry conditions near dry watercourses and occasionally moist hollows, Kemchik River.

No. 199. Alluvial and gravel deserts, Borotella plains and south of Dzungarian Gap.

It is probable that these two specimens are the same species, perhaps *T. Pallasii*, Desv.

Reaumuria soongarica, *Maxim.*

No. 200. Alluvial desert, Borotella plains (often where saline).

Distribution. Turkestan, Altai, western Mongolia, and northern Thibet.

PORTULACACEÆ.

Claytonia arctica, *Adams.*

No. 378. Summit of Mount Ulug Taiga, dry patches on rocky boulders over 1800 m., Sayansk Mts.

Distribution. Siberia, N. Mongolia, and Hall Island in the Behring Sea.

MALVACEÆ.

Althæa rosea, *Cav.*

No. 123. Southern aspects, 900 to 1700 m., southern Great Altai Mts., Upper Kran River, basin of Black Irtish, Dzungaria.

Distribution. South-eastern Europe, Asia Minor, Cyprus, Kashmir, N.W. India, southern China, and Japan.

LINACEÆ.

Linum perenne, *Linn.*, *β.* sibiricum, *Schiede.*

No. 461. Dry valley steppe near rivers, when occasionally flooded, Ulu Kem.

Distribution. N.W. Mongolia, Dahuria, and southern China.

ZYGOPHYLLACEÆ.

Nitraria Schoberi, *Linn.*

No. 198. Alluvial and gravel deserts, Borotella plains and south of Dzungarian Gap.

Distribution. Southern Russia, Caspian Sea, Turkestan and Mongolia, Persia and Afghanistan ; N. Africa as far south as Senegal.

GERANIACEÆ.

Oxalis Acetosella, *Linn.*

No. 298. Shade of Spruce and Larch and Pine forest, where the soil is wet, associated with mosses, ferns, and lycopodiums, Amil River.

Distribution. Europe, North America, Kashmir, northern Himalayas, and Amur River.

Geranium albiflorum, *Ledeb.*

No. 297. Shade of Spruce, Birch, and Poplar forests on the Amil River. Very common and universal.

Distribution. Siberia, Yenisei and Baikal, southwards through northern Mongolia to Dzungaria and Turkestan.

The flowers of this species are purple in the bud, but are pale when fully expanded.

RUTACEÆ.

Peganum Harmala, *Linn.*

No. 203. Desert on the Chuguchak plain, Dzungarian Gap, and Borotella plains.

Distribution. Southern Europe, northern Africa, tropical Arabia, Persia, Afghanistan, extending eastwards through N.W. India into southern China.

LEGUMINOSÆ.

Thermopsis lanceolata, *R. Br.*

No. 113. Dunes of blown sand in the desert in the Achit-Nor basin.

Distribution. Southern Siberia, Mongolia, western China, and northern Thibet.

Trifolium Lupinaster, *Linn.*

No. 393. Steppe of valley-bottoms, Shabash and Kamsara Rivers.

No. 431. Shade of Larch forest, Upper Bei Kem and Doro Kem Rivers.

Distribution. Russia eastwards to Japan.

Lotus corniculatus, *Linn.*

No. 456. Driest part of valley steppe, Ulu Kem.

Distribution. World-wide.

Halimodendron argenteum, *DC.*

No. 163. Alluvial and sandy plains at 760 m. and under. Medium dry conditions, near dry watercourses and occasionally moist hollows, Kemchik River.

Distribution. The Caucasus Mts., Dzungaria, and N. Mongolia.

Caragana arborescens, *Lam.?*

No. 414 *a*. Terraces of Kamsara and Upper Bei Kem Rivers and desert parts of open steppe, between the flood-line of the river and the Larch-forest zone.

Distribution, Turkestan and Tomsk eastwards to Manchuria.

The material is poor, there being no flowers or fruit.

CARAGANA BUNGEI, *Ledeb.*
No. 414 *b.*
Distribution. N. Mongolia.

CARAGANA PYGMÆA, *DC.*
No. 2. Steppe near Minnusinsk at 270 m.
No. 202. Alluvial and gravel desert on the Borotella plains.
Distribution. Southern Siberia, Mongolia, Turkestan, N. China, and western Thibet.

CARAGANA SPINOSA, *DC.*
No. 479. Dry alluvial steppe, Ulu Kem, Dja Kul.
Distribution. Southern Siberia, Mongolia, and N. China.

CARAGANA sp.
No. 179. Medium dry sandy places in the plains of the Upper Irtish, 460 to 550 m.

This plant agrees with *C. conferta*, Benth., as regards stipules, spines, and pubescence, but the bark is totally different.

ASTRAGALUS ALPINUS, *Linn.*
No. 445. On dry sandy banks by the River Bei Kem. Under flood-mark and only growing in summer.
Distribution. Alpine regions of Europe, Asia, and N. America.

ASTRAGALUS DASYGLOTTIS, *Fisch.*
No. 458. Driest part of the Ulu Kem Valley steppe.
Distribution. The Altai and Turkestan.

ASTRAGALUS PALLASII, *Fisch.*
No. 181. Dry stony desert hills at 600 m., Karin Nairn Hills, Upper Irtish basin.
Distribution. Turcomania and Turkestan.

ASTRAGALUS sp., § Phaca, *Bunge.*
No. 401. Sandy banks near the Lower Kamsara River.

OXYTROPIS sp. *cf.* O. platysema, *C. A. Mey.*
No. 52. Mountain-sides above 2150 m. where the soil is either moist and peaty and covered with alpine meadows, or dry shady slopes where some soil has accumulated. W. Tannu-ola Mts. at the head of the Saklya River.

This specimen differs from *O. platysema* in having calyx-teeth one-third the size of the tube, teeth 2 mm., tube 7 mm., instead of being equal in size. The vexillum also is emarginate, and not entire as in *O. platysema.*

OXYTROPIS sp. *cf.* O. sulfurea, *Fisch.*

No. 395. Open steppe valleys of the Shabash and Kamsara Rivers.

OXYTROPIS TRAGACANTHOIDES, *Fisch.*

No. 115. Stony desert on hill-sides and in plateau valleys up to 2450 m. under the driest vegetative conditions in the S. Tannu-ola Mts., Achit-Nor basin, and Great Altai Mts., north side, in the Suok Valley.

Distribution. The Altai region.

This plant is used for fuel by the Mongols.

GLYCYRRHIZA URALENSIS, *Fisch.*

No. 175. Alluvial plains where slightly moist or sand dunes above water-level. Irrigated fields near Dja Kul and sandy plains of Upper Irtish basin.

G. uralensis differs considerably from *G. glandulifera.* In the Herbarium, however, there is some confusion, and there appear to be intermediate forms between this plant and the true *G. glandulifera* of Waldstein and Kitaibel, which is a European plant.

ALHAGI KIRGHISORUM, *Schrenk.*

No. 204. Alluvial flats between Ala Kul and Ulu Nor, Dzungarian Gap.

Distribution. Dzungaria.

LATHYRUS FROLOWII, *N. D. Simpson,* sp. nov. (Pl. **21.** figs. 8–14.)

Ab *Orobo verno* L., foliis mucronatis nec acuminatis, foliorum rachi sæpe dilatata, foliolis in margine minutissime papilloso-denticulatis, racemis paucifloris et calycis dente inferiore lanceolato acuto nec lineari-lanceolato acuminato distinguendus.

Caules glabri, canaliculati. *Folia* 3–4-juga ; rachis glabra, sæpe dilatata ; foliola 2–4 cm. longa, 0·6–1 cm. lata, membranaceo-chartacea, anguste oblonga, mucronata nec acuminata, margine papilloso-denticulata, nec ciliolata ; stipulæ semisagittatæ, superiores foliolis duplo breviores usque ad 2 cm. longæ, inferiores multoties minores 0·7 cm. longæ. *Flores* purpurei, pedicellati ; pedunculi pauciflori 6 cm. longi, 1–4-flori nec pluriflori. *Calyx* 1 cm. longus, dentibus supremis abbreviatis mucronatis 0·2 cm. longis, infimo 0·5 cm. longo tubum subæquante, lanceolato, acuto. *Corolla* calyce duplo longior; vexillum circiter 1·8 cm. longum, 0·9 cm. latum ; alæ 1·4 cm. longæ, 0·4 cm. latæ, carina breviores ; carina 1·5 cm. longa, obtusa. *Ovarium* sessile, 14–15-ovulatum ; stylus lateraliter compressus 0·6 cm. longus. *Legumen* compressiusculum, glabrum.—*Orobus Frolowii*, Fisch. MSS.

No. 269. On cultivated or semi-cultivated land and in the shade of forests near Kushabar and Amil River.

Distribution. Altai, *Ledebour* ! *ex Herb. Besser* ! *Prescot* ! Siberia, Yenisei, Torgaschina, *H. Wilh. Arnell* ! *in Herb. Kew.*

LATHYRUS LINNÆI, *Rouy*, var. ORIENTALIS, *N. D. Simpson*, comb. nov.

No. 303. Open spaces in Poplar, Birch, and Spruce forests on the Amil River.

Orobus luteus, L., var. *orientalis*, Fisch. et Mey. Index 3 Sem. horti Petrop. p. 42.

L. luteus, Peterm. Deutschl. fl. p. 155 (1849), non Munby, Fl. Alger. p. 78 (1847).

Distribution. Turkestan and N. Mongolia.

LATHYRUS PRATENSIS, *Linn.*

No. 422. On the edges of half-dried swamps in open steppe valley-bottoms, Upper Bei Kem.

Distribution. North temperate regions.

SOPHORA ALOPECUROIDES, *Linn.*

No. 147. In the cultivated part of valleys near irrigation canals, Sharasume, Upper Irtish basin.

Distribution. Asia Minor, Afghanistan, Baluchistan, Dzungaria, and the Altai.

ROSACEÆ.

PRUNUS PADUS, *Linn.*

No. 281. A shrub under Birch and Spruce, very common up to 600 m., Amil River.

Distribution. Europe, N. and Central Asia, and Thibet.

SPIRÆA HYPERICIFOLIA, *DC.*

No. 41. Barren and dry hill-slopes. Desert floral types in the Kemchik Basin, Minnusinsk steppe, and southern slopes of the Tannu-ola Mts.

No. 140. Southern aspects from 1370 m. to open stony desert valleys at 760 m., Kran River near Sharasume.

Distribution. Dahuria, Mongolia, Turkestan, extending westwards to the Caucasus and southern Russia, *C. K. Schneider.*

SPIRÆA MEDIA, *Schmidt*, var. *c.* SERICEA, *Regel.*

No. 295. Open glades in forests and on hill-slopes near the Amil River.

Distribution. Northern Mongolia, Manchuria, and Sachalin, *C. K. Schneider.*

RUBUS ARCTICUS, *Linn.*

No. 347. Drying swamps amongst moss, or open steppe in valleys where it is dry, Sistikem, Upper Yenisei, and Japsa Rivers.

Distribution. Subarctic Europe, Asia, and America. Europe, southwards to the Baltic ; Asia, southwards to the Himalayas ; N. America, Canada and British Columbia, *Focke.*

Rubus Chamæmorus, *Linn.*

Drying swamp association, Petropolowsk on the Amil River.

Distribution. In subarctic Europe, Asia, and America. In Europe southwards to the Riesen-Gebirge. In America down to the Rocky Mts., and in northern Japan, *Focke.*

Rubus purpureus, *Bunge.*

No. 467. Associated with stunted Larch and *Pinus* forests on dry rocky slopes, Japsa Mts. near Bei Kem rapids.

Distribution. N. China and Japan and west temperate Himalayas.

Dryas octopetala, *Linn.*

No. 9. Dry summit of Kizil Taiga, where it is not too rocky and where the surface is even.

Distribution. Temperate arctic and alpine regions in the Northern hemisphere.

Potentilla fruticosa, *Linn.*, var. vulgaris, *Willd.*

No. 350. Open steppe in bottom of the valleys of the Sistikem and Chuguchak Rivers.

Distribution (of sp.). Throughout Europe and Asia extending as far south as the Himalayas, also in N. America down to California, *Th. Wolf.*

Potentilla bifurca, *Linn.*, var. typica, *Th. Wolf.*

No. 418. River terraces and desert parts of open steppe between flood-line of river and Larch-forest zone, Kamsara and Upper Bei Kem Rivers.

Distribution. From Russia and Greece eastwards through Asia Minor and ersia into Turkestan and Mongolia and the Himalayas, *Th. Wolf.*

Potentilla bifurca, *Linn.*, var. canescens, *Ledeb.*

No. 184. On a low sandy plain in the valley of the Upper Irtish.

Distribution (of variety). Central Asia, *Th. Wolf.*

Potentilla sericea, *Linn.*, var. dasyphylla, *Ledeb.*

No. 37. Dry desert hill-slopes of the western Tannu-ola Mts. and upland valley plateaus up to 2150 m.

Distribution. From Russia extending eastwards to Kamtchatka and the Behring Straits, *Th. Wolf.*

Potentilla viscosa, *Donn.*

No. 465. Dry valley steppe near Ulu Kem when occasionally flooded.

Distribution. Central Asia from the Ural Mts. to Manchuria, *Th. Wolf.*

POTENTILLA NIVEA, *Linn.*, var. ELONGATA, *Th. Wolf.*

No. 53. Mountain-sides at the head of the Saklya River, above 2100 m., where the soil is moist or in peaty meadows or dry shady slopes where some soil has accumulated.

No. 387. Open dry steppe in valley-bottoms and sandy slopes near the Shabash River.

Distribution. Turkestan, N. Mongolia, and Pamir, *Th. Wolf.*

POTENTILLA CHRYSANTHA, *Trev.*, var. ASIATICA, *Th. Wolf.*

No. 128. Southern aspects from 900 to 1700 m., southern Great Altai Mts., Upper Kran River in the basin of the Black Irtish, Dzungaria.

Distribution (of variety). Turkestan, the Altai, and western Mongolia, *Th. Wolf.*

POTENTILLA ELEGANS, *Cham. et Schlecht.*

No. 373. Highest mountain-tops 1950 m., very dry conditions. Also open steppe valley bottoms with dry flora in Shabash Valley, Kamsara, and Kandart Mt. Range, Sayansk Mts.

Distribution. Kamtchatka, Baikal region, Altai, N.W. Mongolia, *Th. Wolf.*

POTENTILLA GELIDA, *C. A. Mey.*

No. 252 *a.* Edges of cultivated land bordering the Birch and Pine forest, on very friable peaty sand, rolling hills, 350 m. above sea, Kalmakof, 40 versts W. of Minnusinsk.

Distribution. Arctic and alpine regions in Norway, Lapland, the Caucasus, Armenia, Turkestan, and southern Siberia, *Th. Wolf.*

POTENTILLA SUBACAULIS, *Linn.*

No. 252 *b.* Habitat and locality the same as the preceding.

Distribution. Throughout Russia and Siberia to the Amur River, southwards to Mongolia, northern Thibet, and extending into western China, *Th. Wolf.*

POTENTILLA FRAGARIOIDES, *Linn.*

No. 265. Cultivated land and shade of Pine forests, Kushabar.

Distribution. Throughout Siberia extending eastwards to Korea and Japan, and in N. Mongolia, the Altai, northern China, and Manchuria, *Th. Wolf.*

POTENTILLA ANSERINA, *Linn.*

No. 454. Driest part of valley steppe, Ulu Kem River.

No. 484. Very dry areas in river valleys, both in sand and flint desert, Dja Kul and Ulu Kem.

Distribution. Temperate regions and alpine parts of warmer countries all over the world except in southern Africa, *Th. Wolf.*

SIBBALDIA PROCUMBENS, *Linn.*

No. 356. On dry glacial moraines, Japsa River, Sistikem.

Distribution. Arctic and temperate regions.

SIBBALDIA TETRANDRA, *Bunge.*

No. 71. Alpine meadows above 2150 m. and rocky slopes and screes even up to 3000 m., W. Tannu-ola and on mountains south of Saklya River.

Distribution. Altai, Alatau, and Tian-Shan Ranges.

CHAMÆRHODOS ALTAICA, *Bunge.*

No. 64. Upland plateau valleys or dry steppe at about 2150 m., W. Tannu-ola Mts.

Distribution. Altai region.

ALCHEMILLA VULGARIS, *Linn.*

No. 120. Shade of higher Larch forest from 1800 to 2100 m., Great Altai Range.

No. 321 *b.* In Spruce Taiga at 1000 m. growing under melting snow, Chuguchak range, Amil River.

Distribution. Temperate regions of the Northern hemisphere.

SANGUISORBA OFFICINALIS, *Linn.*

No. 394. Steppe valleys, natural meadows, shade of Larch forests. Shabash, Kamsara, and Upper Bei Kem Rivers; also Kemchik and N. slopes of W. Tannu-ola Mts.

Distribution. Northern temperate and arctic regions.

SANGUISORBA ALPINA, *Bunge.*

No. 121. Shade of higher Larch forest 1800 to 2150 m., southern parts of the Great Altai Range, Upper Kran River, and the basin of Black Irtish.

Distribution. Temperate Asia, China and Japan.

ROSA SPINOSISSIMA, *Linn.*

No. 27. On mountain slopes of the Tula Mts. at 2150 m., where the ground is stony.

Distribution. Throughout Europe and in the Altai region, *Lindley.*

ROSA ACICULARIS, *Lindl.*

No. 400. Shade of Larch forests and dry valley slopes chiefly in shade, Lower Shabash and Kamsara Rivers.

Distribution. China, Japan, and in the Amur province and parts of India, *Lindley.*

SORBUS TIANSHANICUS, *Rupr.*

No. 142. Stony valley-bottoms near the Kran River near Sharasume in the southern Great Altai.

Distribution. Turkestan.

CRATÆGUS SANGUINEA, *Pall.*

On the banks of the Kran River.

Distribution. Siberia.

COTONEASTER MELANOCARPA, *Lodd.*

No. 138. Southern aspects at 900 to 1500 m., Great Altai, basin of the Black Irtish, Upper Kran River.

No. 499. Dry hill and mountain slopes associated with a desert flora on the southern side of Kizil Taiga on the Lower Kemchik River.

Distribution. Mongolia, Tian Shan, and Tannu-ola Mts.

SAXIFRAGACEÆ.

SAXIFRAGA MELALEUCA, *Fisch.*

No. 51. Mountain-sides above 2150 m. where the soil is moist and peaty, in alpine meadows, or on dry shady slopes where soil has accumulated, Western Tannu-ola Mts.

No. 376. Mountain summits over 1800 m. where there are dry patches amongst rocky boulders, Ulug Taiga, Sayansk Mts.

Distribution. Altai, Baikal, and Dahuria, *Engler.*

SAXIFRAGA OPPOSITIFOLIA, *Linn.*

No. 54. Mountain-sides above 2150 m. where the soil is moist and peaty, forming alpine meadows, or dry shady slopes where some soil has accumulated, W. Tannu-ola and mountains at the head of the Saklya River, both N. and S. slopes.

Distribution. Northern and alpine Europe; Asia southwards to Thibet; N. America southwards to the Rocky Mts., *Engler.*

These specimens have very large flowers.

SAXIFRAGA SIBIRICA, *Linn.*

No. 324. Rocks on shores of the Amil River, altitude 670 m.

Distribution. Caucasus to Irkutsk, W. Thibet, and N.W. Himalayas, *Engler.*

SAXIFRAGA CERNUA, *Linn.*

No. 81. Screes and rocky steep slopes on mountain-sides from 2450 to 3350 m., Kundelun Mts.

Distribution. Europe, arctic Siberia down to western Thibet, and arctic North America, *Engler.*

SAXIFRAGA HIRCULUS, *Linn.*

No. 496. High upland meadows and in the shade of Larch forests, on moist peat soil and shady slopes up to 3000 m., Kizil Taiga, Kemchik Valley, and Bogdon and Saglig Valleys.

Distribution. Northern and central Europe ; Asia southwards to the Himalayas and arctic North America, *Engler.*

SAXIFRAGA CRASSIFOLIA, *Linn.*

No. 322. Crevices in dry slate and schistose rocks, Chukuok Ridge, Amil River.

Distribution. Siberia, Baikal region, the Altai, and N. Mongolia.

CRASSULACEÆ.

COTYLEDON SPINOSUS, *Linn.*

No. 442. Dry sandy slopes on sides of valleys of the Upper Bei Kem.

Distribution. South and eastern Siberia, Turkestan, N. Mongolia, and eastwards through N. China to Manchuria.

SEDUM FASTIGIATUM, *Hook. fil. et Thoms.*

No. 69. Alpine meadows above 2100 m. and rocky slopes and screes up to 3000 m., Western Tannu-ola and mountains south of Saklya River.

No. 83. Screes and steep rocky slopes on mountain-sides from 2050 to 3350 m. and over, and glacial moraines, Kundelun Mts.

Distribution. Kashmir and Thibet.

SEDUM HYBRIDUM, *Linn.*

No. 416. River terraces and driest parts of open steppe between the flood-line of rivers and the Larch-forest zone, Kamsara and Upper Bei Kem Rivers.

Distribution. Turkestan eastwards to Okhotsk, extending southwards into northern China.

SEDUM QUADRIFIDUM, *Fisch. et Mey.*

Distribution. The Altai and North Mongolia, Kashmir, Thibet, and northern India.

SEDUM RHODIOLA, *DC.*

No. 366. Wet places under snow-drifts on the sides of the Sayansk Mts. in Upper Kandart and Japsa systems.

Distribution. Throughout Europe, northern Asia, and in North America, southwards to the Rocky Mts. in North America and the Himalayas in Asia.

SEDUM sp. nov.?

No. 30. Dry peat in valley bottoms, Kindergay Valley.

DROSERACEÆ.

Drosera intermedia, *Hayne.*

Drying swamp type of vegetation, Petropolowsk, Amil River.

Distribution. North America, Europe, and the West Indies, *Diels.*

Drosera rotundifolia, *Linn.*

Drying swamp type of vegetation, Petropolowsk, Amil River.

Distribution. North America, arctic and temperate Europe, Siberia, and Asia Minor eastwards to Japan, *Diels.*

HALORAGEÆ.

Hippuris vulgaris, *Linn.*

No. 88. Marshes and stagnant pools or lagoons near Lakes Uryu and Achit Nor and sluggish streams.

Distribution. North temperate regions.

Myriophyllum verticillatum, *Linn.*

Specimina sterilia, no. 5. Lake Sul-kul, Lower Kemchik.

Distribution. North temperate regions.

ONAGRACEÆ.

Trapa natans, *Linn.*

No. 172. Stagnant backwaters on the Upper Irtish River.

Distribution. Central and southern Europe, the Caspian region, and Asia Minor.

Epilobium hirsutum, *Linn.*

No. 46. By mountain streams between 2150 and 2450 m., head-waters of the Saklya River.

Distribution. Temperate and arctic regions in the Old World, excluding Australia and New Zealand, *Haussknecht.*

UMBELLIFERÆ.

Bupleurum longifolium, *Linn.*, var. *β.* aureum, *H. Wolff.*

No. 386. Dry steppe valleys, Shabash River.

Distribution. Southern Russia, Turkestan, southern Siberia, N. China, and Amur, *H. Wolff.*

Bupleurum multinerve, *DC.*

No. 49. Sides of the Tannu-ola Mts. above 2150 m., where the soil is either moist and peaty, forming alpine meadows, or dry shady slopes where some soil has accumulated.

Distribution. From eastern Russia through central Asia to Manchuria and Japan, extending southwards to Turkestan and N. Thibet, *H. Wolff.*

BUPLEURUM FALCATUM, *Linn.*, var. λ. BICAULE, *Wolff.*

No. 34. Dry desert hill-slopes and upland valley plateaus up to 2150 m., Bodhon Valley, W. Tannu-ola Mts.

Distribution. Altai region and Dahuria, *H. Wolff.*

CARUM CARVI, *Linn.*

No. 325. Sandy banks near the Amil River and streams.

Distribution. Northern and central Europe, Persia and Afghanistan, throughout Siberia, and in Canada.

MYRRHIS ODORATA, *Scop.*

No. 299. Shade of Spruce, Birch, and Poplar forests, Amil River.

Distribution. Throughout Europe and Asia Minor.

SCHULTZIA CRINITA, *Spreng.*

No. 381 *a.* Summit of Ulug Taiga, dry patches on rocky boulders over 1800 m.

Distribution. Southern Siberia, Altai Mts., and N.W. Mongolia.

LIGUSTICUM MUTELLINA, *Crantz.*

No. 381 *b.*

Distribution. South-eastern Europe and S. Siberia.

PEUCEDANUM PRICEI, *N. D. Simpson*, sp. n. (Plate **23.** figs. 1–3.)

Ab affine *P. vaginato*, Turcz., radice non repente, involucro oligophyllo, involucelli foliolis acuminatis quam umbellulis brevioribus, fructibus obcordatis non orbiculato-ellipticis, valleculis bi- vel trivittatis, commissura 6-vittata recedit.

Herba glaberrima, radice crassa ; caulis solitarius, glaber, circiter 45 cm. altus, teres, striatus, apice sulcatus, basi foliorum fibrosis rudimentis obtectus, parce foliosus. *Folia* basalia 6–12 cm. longa, subbipinnata, 3-juga, pinnis 3- vel 2-sectis vel summis simplicibus basi lacinia extus addita, laciniis anguste lanceolato-linearibus acutis 1–1·5 (raro 2) cm. longis, 0·1–0·2 cm. latis ; petiolus ad 2·8 cm. longus, inferne in vaginam ampliatus ; folia caulina similia, sed superne gradatim reducta, summum trisectum, petiolo in vaginam commutato. *Umbellæ* 2, altera terminalis, altera ex axilla folii supremi orta, minor ; terminalis 10–15-radiata ; radii sulcati, longitudine inæquales, ad 3·2 cm. longi ; involucrum 1- vel rarius 2-phyllum ; phylla filiformia, 0·4 cm. longa ; umbellulæ multifloræ, involucella polyphylla, phyllis linearibus longe acuminatis margine membranaceis inæqualibus 0·45 cm. longis ; pedicelli ad 1 cm. longi. *Flores* sicco albi ; petala late spatulata, apice inflexa. *Mericarpia* obcordata, 0·55 cm. longa, 0·4 cm. lata ; alæ albidæ, 0·1 cm. latæ ; valleculæ bi- vel trivittatæ, commissura 6-vittata ; stylopodium et styli persistentes.

No. 108. On moist well-drained alluvial soil, not far from lakes and streams, Achit Nor, N.W. Mongolia.

HERACLEUM SIBIRICUM, *Linn.*

Distribution. South-eastern Europe and N. Asia.

CAPRIFOLIACEÆ.

SAMBUCUS RACEMOSA, *Linn.*

No. 318. Shade of Spruce and other "Taiga," also above the Spruce line, near the Amil River.

Distribution. Central and southern Europe, Siberia south and east, China, Japan, and Korea.

LINNÆA BOREALIS, *Linn.*

No. 26. Dry peat in valley-bottoms and often with Larch shade association, northern Tannu-ola Mts.

No. 136. Shade of Larch forest 1700 m. to 1800 m., on northern aspects down to 1200 m., southern Great Altai Mts., Upper Kran River, basin of Black Irtish.

Distribution. Throughout Europe, Siberia and Japan, and in N. America.

LONICERA MICROPHYLLA, *Willd.*

No. 40. Common desert bush in stony places, especially in shaded gullies or northern aspects when too dry for the Larch association. Kemchik River, south slope of the Tannu-ola Mts., and Upper Kobdo River.

Distribution. Afghanistan, Turkestan, Altai Mts., Mongolia. In Kansu and Thibet and in Kashmir, *A. Rehder.*

LONICERA CÆRULEA, *Linn.*, var. ALTAICA, *Sweet.*

No. 135. Shade of Larch forest 1700 m. to 1800 m., and on northern aspects down to 1200 m. Southern Great Altai Mts., Upper Kran, River and the basin of Black Irtish.

Distribution (of var.). N. Europe and N. Asia to Japan, *A. Rehder.*

LONICERA CÆRULEA, *Linn.*

No. 276 *a*. Forms a small shrub in the shade of Birch and Poplar forest and on dry slopes. Kushabar, south slopes of the Sayansk Mts., and the north slopes of the Tannu-ola Mts.

Distribution. North America: south to Pennsylvania, Wisconsin, Wyoming to California. Northern Asia: south to Hondo and Thibet. Turkestan and Asia Minor. N. and middle Europe and mountains in the South of Europe. *A. Rehder.*

LONICERA TATARICA, *Linn.*

No. 137. Southern aspects 900 to 1700 m. on the Great Altai Mts., Upper Kran River, and in the basin of the Black Irtish, Dzungaria.

Distribution. Central Asia to south Russia: from the Altai to the Ural Mts. and the Volga, *A. Rehder.*

RUBIACEÆ.

GALIUM BOREALE, *Linn.*

No. 391. Open steppe valley-bottoms, dry type of flora, Shabash and Kamsara Rivers.

Distribution. North and central Europe, Turkestan, Mongolia, China and eastern Siberia, extending down to Kashmir and northern India, and in North America.

GALIUM CRUCIATA, *Scop.*, var. *β.* CHERSONENSE, *DC.*

No. 296. On dry banks of the Amil River in open glades of Birch and Poplar and Spruce forest.

Distribution. Central Europe, the Caucasus, and Asia Minor.

GALIUM TRIFIDUM, *Linn.*

No. 436. Swamps at the edges of Lake Todju Kul.

Distribution. N. Europe, eastern Siberia, Japan, N. America, and Mexico.

GALIUM ULIGINOSUM, *Linn.*

No. 437. Swamps at the margin of Lake Todju Kul.

Distribution. Throughout Europe and in N.W. America.

GALIUM VERUM, *Linn.*, var. LEIOCARPUM, *Ledeb.*

No. 421. Open meadows in valleys, shade of Larch forest. Dry hill-slopes with desert flora, Kamsara and Upper Bei Kem, Kemchik, and W. Tannuola Mts.

Distribution. Europe, Asia Minor, Persia, and Japan.

ASPERULA ODORATA, *Linn.*

No. 301. Shade of Spruce, Birch and Poplar forests, Amil River.

No. 315. Shade of *Abies,* Poplar, and Birch forests, Amil River.

Distribution. Europe, Asia Minor, Persia, N.W. India, and Japan.

VALERIANACEÆ.

PATRINIA SIBIRICA, *Juss.*

No. 14. Dry mountain summits when not too rocky and when the surface is even, Kizil Taiga.

No. 361. Dry summits of Sayansk Mts., Upper Kandart and Japsa systems: associated with Reindeer Moss.

Distribution. Siberia and northern Mongolia.

VALERIANA SAMBUCIFOLIA, *Mikan.*

No. 392. Open steppe valley-bottoms, Shabash and Kamsara Rivers.

Distribution. Europe, Siberia, and Manchuria.

DIPSACEÆ.

SCABIOSA OCHROLEUCA, *Linn.*

No. 468. Dry valley steppe near the Lower Bei Kem where it is occasionally flooded.

Distribution. Southern Europe, and S. Siberia and N. Mongolia.

COMPOSITÆ.

ASTER ALPINUS, *Linn.*

No. 13. Dry summit of Kizil Taiga when not too rocky.

No. 28. Mountain slopes and dry steppe valleys from 1200 to 2900 m. Tula Mt. at 2100 m., W. Tannu-ola Mt.

No. 390. Open steppe valley-bottoms, dry type of flora, Shabash and Kamsara Rivers.

Distribution. Europe, Siberia, Turkestan, and China.

ERIGERON UNIFLORUS, *Linn.*

No. 56. Dry shady slopes where some soil has accumulated, sides of W. Tannu-ola Mts. at 2600 m.

Distribution. Alpine and arctic regions of the Northern Hemisphere.

ANTENNARIA DIOICA, *Gärtn.*

No. 349. Open steppe in bottoms of the valleys of the Japsa and Sistikem Rivers.

Distribution. Throughout Europe, Siberia, Asia Minor, and Turkestan, also in Japan and North America.

LEONTOPODIUM ALPINUM, *Cass.*

No. 21. Dry steppe on terraces and screes near the Upper Djardan and Kundergay. Dry plateau valley, Bogdon, W. Tannu-ola Mts.

Distribution. Central and southern Europe, Turkestan extending eastwards to China and in northern India.

HELICHRYSUM ARENARIUM, *DC.*

No. 195. Alluvial downs on N.W. Barlik Range near Dzungarian Gap.

Distribution. Eastern Europe, the Altai, Turkestan, and southwards into Afghanistan.

INULA BRITANNICA, *Linn.*

No. 463. Dry valley steppe near the River Ulu Kem, where it is occasionally flooded.

Distribution. Europe, Turkestan eastwards to Japan.

ACHILLEA IMPATIENS, *Linn.*

No. 389. Open and dry steppes in valley-bottoms, Upper Shabash River.

Distribution. Siberia and the Altai region.

ACHILLEA MILLEFOLIUM, *Linn.*

No. 127. Southern aspects from 900 to 1700 m. Southern Great Altai Mts., Upper Kran River, basin of Black Irtish, Dzungaria.

FORMA. No. 424. Driest parts of the open steppe between the flood-line of river and the Tomsk forest zone, Upper Bei Kem and Dora Kem.

Distribution. Temperate and alpine regions of the Northern hemisphere.

ALLARDIA GLABRA, *Decne.*

No. 82. Screes and steep rocky slopes on mountain-sides from 2450 to 3350 m. and on recently evacuated glacial moraines, Kundelun Mts.

Distribution. Turkestan and northern Mongolia southwards into Thibet and the Himalayas.

TANACETUM BOREALE, *Fisch.*

No. 19. Shade of the Larch forests, Middle Bei Kem and Kundergay Rivers.

Distribution. Norway, Turkestan, throughout Siberia and North America.

TANACETUM FRUTICULOSUM, *Ledeb.*

No. 110. Stony desert in Achit Nor basin under driest conditions and on the dry mountain-sides of the Great Altai (north side) up to 2450 m.

Distribution. Turkestan, northern Mongolia, the Altai, and Pamir.

ARTEMISIA ARGYROPHYLLA, *Ledeb., ex icon. et descript.*

No. 67. Upland plateau valleys when very dry, with desert flora, Bogdon and Saklya Valleys, Turgun Valley; also upland valleys on the north side of the Great Altai Mts.

Distribution. Altai, *Ledebour.*

ARTEMISIA CAMPESTRIS, *Linn.*

No 194. Alluvial and gravel-desert, Dzungarian Gap.

Distribution. Throughout Europe, Asia Minor, southern Siberia, Turkestan, eastwards to China and Manchuria.

ARTEMISIA FRIGIDA, *Willd.*

No. 38. Dry desert hill-slopes in the Bodhon Valley and upland valley plateaus up to 2150 m.

Distribution. Southern Siberia, Mongolia, Turkestan, and North America.

ARTEMISIA LERCHEANA, *Weber.*

No. 174. Medium dry conditions, sand-dunes and sandy silt deposits just above the water-table. Sandy plains of the Upper Irtish basin.

No. 185. Plateau steppe, north of Chugu-ola Pass, Dzungaria.

No. 188. Alluvial plains on the Chuguchak Steppe.

Distribution. Asia Minor, Siberia, Mongolia, and Turkestan.

ARTEMISIA LERCHEANA, *Weber*, var. HUMILIS, *Ledeb.*

No. 143. Stony desert on hill-sides at 750 m. in the Kran River Valley in the Sharasume district.

ARTEMISIA SERICEA, *Weber*, var. *β*. GRANDIFLORA, *DC.*

No. 131. Southern aspects from 900 to 1700 m. in the Great Altai Mts., Upper Kran River, and the basin of the Black Irtish.

Distribution (of the species). Turkestan, Altai, N. Mongolia, and Dahuria.

ARTEMISIA SIEVERSIANA, *Willd. non Ehrh.*

No. 85. Stony desert under driest vegetative conditions, N.W. Mongolia, Khanofski Haslum.

Distribution. Altai and northern Mongolia.

TUSSILAGO FARFARA, *Linn.*

No. 314. Sandy banks by the side of streams at 600 m. On the Chukuok Ridge, N. of Sayansk Mts., and near the Amil River.

Distribution. Arctic and temperate regions of the Northern hemisphere.

PETASITES LÆVIGATUS, *Reichb.*

No. 310. Sandy island in the Amil River, often flooded.

Distribution. Tomsk and the Altai.

DORONICUM ALTAICUM, *Pall.*

Northern side of the Sayansk Mts.

Distribution. Altai, Mongolia, and Yunnan.

Senecio aurantiacus, *DC.*, δ. capitatus, *DC.*

No. 60. Boggy alpine meadows on the sides of the W. Tannu-ola Mts. at the head of the Saklya River.

Distribution. Central and south-eastern Europe, Altai, North Africa.

Senecio nemorensis, *Linn.*, β. octoglossus, *Koch.*

No. 20. Shade of Larch forest, Middle Bei Kem and Kundergay Rivers.

Distribution. Southern Europe, throughout Siberia, northern Russia, and Turkestan.

Senecio palustris, *DC.*

No. 96. Mud flats on the edges of shallow desert lakes such as Achit Nor; the plant is half-submerged.

Distribution. Europe, Siberia, N. Mongolia, and N. America.

Senecio Ligularia, *Hook. f. et Thoms.*

No. 12. Dry summit of Kizil Taiga where the surface is even and not too rocky.

Distribution. Southern and eastern Europe, Turkestan, the Altai and Irkutsk eastwards to Japan.

Ligularia sibirica, Cass.

Senecio Turczaninowii, *DC.*

No. 61. Boggy alpine meadows on sides of Western Tannu-ola Mts.

Distribution. Dahuria.

Senecio Pricei, *N. D. Simpson*, sp. n. (Pl. **22**. figs. 8–12.)

Cremanthodii habitu, affinitate dubia, foliis ficarioideis, caule superne copiose floccoso-lanuginoso.

Herba rhizomate brevi præmorso, 10–12 cm. alta; caulis simplex, monocephalus, canaliculatus, dense floccoso-lanatus. *Folia* radcailia longe petiolata, lamina rotundata, basi breviter cuneata, crenata, ad 2 cm. longa, 1–1·7 cm. lata, supra laxe floccoso-lanata, lana detersa, subtus glabra, laxe tenuiter reticulata; petioli ad 5 cm. longi, glabri, late membranaceo-alati; folia caulina sessilia, late lanceolata, acuta, integra. *Capituli involucrum* hemisphæricum, ad 3 cm. diametro; bracteæ 6-seriatæ, 1·3 cm. longæ, anguste lineares, acuminatæ, purpurascentes, extus albido vel fusco-floccoso-lanatæ. *Flores radii* ultra 20; corollæ tubus glaber, 0·4 cm. longus; limbus lineari-ligulatus, apice tridentatus, vix 2 cm. longus, 0·25 latus, 4-nervis; achenium cylindricum, glabrum, 0·25 cm. longum; pappi setæ barbellatæ, 0·6 cm. longæ; styli rami 0·1 cm. longi. *Flores disci* numerosi; corollæ tubus 1·4 cm. longus, supra medium ampliatus, glaber, dentibus ovato-acutis; antheræ acutæ, 0·3 cm. longæ, loculis basi brevissime productis acutis; pappi setæ barbellatæ, 1·2 cm. longæ; achenium cylindricum, glabrum, striatum, 0·4 cm. longum; styli rami 0·1 cm. longi.

No. 50. On mountain-sides above 2150 m. where the soil is moist and peaty, forming alpine meadows, or on dry shady slopes, Western Tannu-ola Mts. and the north and south slopes of the mountains at the head of the Saklya River.

ECHINOPS RITRO, *Linn.*

No. 146. Stony desert on hill-sides at 750 m. in the Kran River valley.

Distribution. Southern Europe, Persia, Turkestan, and the Altai.

CARDUUS ARCTIOIDES, *Linn.*?

No. 449. A member of the Larch association, Sabieff on the Lower Bei Kem.

Distribution. Southern Europe and Russia.

CNICUS IGNIARIUS, *Benth. & Hook. f.*

No. 206. Low desert hills, Kara Daba Pass.

Distribution. Throughout Siberia.

CNICUS SERRATULOIDES, *DC.*

No. 125. Southern aspects from 900 to 1700 m., southern Great Altai Mts., Upper Kran River, and basin of Black Irtish.

Distribution. Northern Mongolia, the Altai, and Turkestan.

SAUSSUREA PRICEI, *N. D. Simpson*, sp. n. (Pl. **21.** figs. 1–7.)

Affinis *S. canæ*, Ledeb., sed caulibus pygmæis, foliis supra laxe araneosis subtus dense albo-tomentosis, capitulis latioribus, corollæ tubo supra medium asymetrice dilatato distincta.

Herba perennis, pygmæa, 1–2 caulibus e rhizomate lignescente, foliorum pristinorum rudimentis fuscis obtectis: caules erecti, 6–7 cm. alti, apice polycephali, dense cano-tomentosi. *Folia* lanceolata, sinnuato-dentata, longitudine 2–4 cm., latitudine 0·5–1 cm., subtus dense albo-tomentosa supra leviter incano-araneosa, margine revoluta. *Capitula* pedunculata, erecta, 5–7 vel plura, dense congesta; involucrum oblongo-turbinatum, parce lanatum, phyllis 5–7-seriatis, exterioribus ovatis submucronatis, interioribus lanceolatis acuminatis apice atroviolaceo margine membranaceo colorato; receptaculum longe setiferum. *Flosculi* rosei; corollæ tubus supra medium asymetrice inflatus, 1·4 cm. longus; limbus 0·2 cm. longus; antherarum caudæ basi floccoso-lanatæ. *Achenia* obscure striata, glabra, 0·3 cm. longa. *Pappus* duplex; pappi setæ exteriores achenium æquantes, barbellatæ, interiores 1 cm. longæ, albidæ, plumosæ.

No. 35. On dry desert hill-slopes and on upland valley plateaus up to 2150 m., Bodhon and western Tannu-ola Valleys.

SAUSSUREA PSEUDO-ALPINA, *N. D. Simpson*, sp. n. (Pl. **22**. figs. 1–7.)

Affinis *S. alpinæ*, DC., sed foliis margine subrevolutis, sæpe fere integris, non acuminatis, corymbo polycephalo, involucro elongato angustiore, phyllis angustis præter margines fere glabris distincta.

Herba perennis, rhizomate gracile; caulis 15–30 cm. longus, canaliculatus, laxe arachnoideus, apice parce lanatus. *Folia* inferiora late lanceolata, acuta, longe pedunculata, minute eroso-dentata, circiter 8 cm. longa, 1–2 cm. lata, margine sæpe revoluta, subtus dense, supra laxe arachnoideo-tomentosa; folia caulina pauca, similia, nisi minora, integra, anguste lanceolata. *Corymbus* dense congestus, polycephalus. *Capitula* breviter vel brevissime pedunculata; involucrum oblongum, 1 cm. altum, fere glabrum, phyllis 6-seriatis in margine violaceis ciliatisque, inferioribus ovatis acutis; receptaculum longe setiferum. *Flosculi* rosei; corollæ 1·3 cm. longæ; tubus supra medium ampliatus, infra constrictus, non basi dilatatus; limbus 0·4 cm. longus; antherarum caudæ basi multisetosæ. *Achenia* 0·2 cm. longa, obscure striata, glabra. *Pappus* duplex; pappi setæ exteriores 0·5 cm. longæ, setoso-barbellatæ, interiores plumosæ, 1·2 cm. longæ.

Locality unknown.

HIERACIUM PRENANTHOIDES, *Vill.*

No. 126. Southern aspects from 900 to 1700 m., southern Great Altai, Upper Kran River, and the basin of the Black Irtish.

Distribution. Europe, Siberia, Persia, and the Himalayas, *Coste.*

TARAXACUM sp.

No. 457. Driest parts of the Ulu Kem valley steppe.

LACTUCA TATARICA, *C. A. Mey.*?

No, 109. Stony desert of the Achit Nor basin under driest conditions and on the dry mountain-sides of the Great Altai up to 2450 m. (on the north side).

Distribution. Southern Europe eastwards to northern Mongolia and in Persia and Thibet.

SCORZONERA AUSTRIACA, *Willd.*

No. 11. Dry summit of Kizil Taiga where the surface is even and not too rocky.

Distribution. Turkestan, Mongolia, Dahuria, and N. China.

SCORZONERA HUMILIS, *Linn.*

No. 345. Dry ground under Larch forest, Kriloff, Sistikem.

Distribution. Southern and central Europe and Siberia.

CAMPANULACEÆ.

CAMPANULA GLOMERATA, *Linn.*

No. 257 *b.* Pine, Birch, Poplar, and Spruce forests on Taiga round about Kushabar and Amil River.

Distribution. Europe, Asia Minor, Siberia, and the Altai.

CAMPANULA ROTUNDIFOLIA, *Linn.*

No. 411. Shade of Larch forest and natural meadows by the sides of Rivers Kamsara and Bei Kem. Up to 1800 m. under Larch, chiefly on northern aspects of the western Tannu-ola Mts.

Specimen without a number. Larch forest shady association, Upper Yenisei basin.

Distribution. Throughout Europe, N. Asia, and N. America.

CAMPANULA SILENEFOLIA, *Fisch.*

No. 59. Mountain-sides above 2150 m. in alpine meadows, where the soil is moist and peaty, or on the dry shady slopes of the western Tannu-ola Mts. and the north and south slopes of the mountains at the head of the Saklya River.

Distribution. Siberia, from the Olenek River and the Baikal region westwards.

ADENOPHORA LAMARCKII, *Fisch.*

No. 490. In sheltered gullies with northerly aspects, chiefly associated with stunted Larch forest. Northern foothills of the Tannu-ola, between Dja Kul and Djardan.

Distribution. Transylvania and Turkestan.

ADENOPHORA MARSUPIIFLORA, *Fisch.*

No. 462. Dry valley steppe near the River Ulu Kem where it is occasionally flooded.

Distribution. Dahuria and Amur.

VACCINIACEÆ.

VACCINIUM MYRTILLUS, *Linn.*

No. 311. In the typical flora of a drying-up swamp encroaching on the *Vaccinium* association, Petropolowsk, Amil River.

Distribution. Europe and North America.

VACCINIUM OXYCOCCUS, *Linn.*

No. 284. In Heath association on half-dried swamps under Birch and Pine, Kushabar, and in the drying swamp association near Petropolowsk on the Amil River.

Distribution. The Northern Hemisphere.

VACCINIUM VITIS-IDÆA, *Linn.*

No. 254. In open Pine and Birch forest or "Taiga," Kalmakop, 40 versts W. of Minusinsk.

No. 344. Dry rocky slopes and on moss in the shade of the forest, Sistikem River.

Distribution. The Northern hemisphere.

ERICACEÆ.

CASSANDRA CALYCULATA, *D. Don.*

No. 283. In Heath association on half-dried swamps under Pine and Birch, Kushabar. Rare.

Distribution. Finland, Siberia, Japan, and North America.

ANDROMEDA POLIFOLIA, *Linn.*

Drying swamp association near Petropolowsk, Amil River.

Distribution. N. Europe, Siberia, Japan, and N. America.

PHYLLODOCE TAXIFOLIA, *Salisb.*

No. 397. On the sides of the Sayansk Mts. from 1200 to 1800 m. in the Upper Japsa and Kandart valleys.

Distribution. Europe, the Baikal region, Kamtchatka, China and Japan, and in North America.

LEDUM PALUSTRE, *Linn.*

No. 282. In Heath association on half-dried swamps under Pine and Birch, Kushabar. Rare.

No. 338. Crevices of rocks on the slopes of the White Mountain ; also in half-dried swamps in the Amil River Valley associated with *Pinus.*

Distribution. Europe, south and eastern Siberia, China, Japan, and N. America.

RHODODENDRON CHRYSANTHUM, *Pall.*

No. 333. Above 1600 m. in the Upper *Pinus* and *Abies* forest zone, White Mountain, Sayansk Range, Tashkel Mts., and Great Japsa Range.

Distribution. Greenland, southern and eastern Siberia.

RHODODENDRON DAURICUM, *Linn.*

No. 354. In open Pine and Birch forest or "Taiga," Kalmakop, 40 versts W. of Minnusinsk.

Distribution. Southern and eastern Siberia.

PYROLA ROTUNDIFOLIA, *Linn.*

No. 346. Dry slopes under Larch on the Sistikem River.

No. 432. Moist shady places on the shores of Todju Kul.

Distribution. Europe, Asia Minor, southern and eastern Siberia, China and Japan, extending southwards into N. India, and in N. America.

PLUMBAGINEÆ.

STATICE GMELINI, *Willd.*, var.

No. 452. Driest part of valley steppe on the Ulu Kem River.

Distribution. South-eastern Europe, Asia Minor, southern Siberia, and Turkestan.

STATICE SPECIOSA, *Linn.*

Dry sandy banks round Lake Todju Kul, Upper Yenesei basin.

Distribution. S.E. Russia, Asia Minor, southern Siberia, N.W. Mongolia, and Turkestan.

PRIMULACEÆ.

PRIMULA ELATIOR, *Jacq.*, var. δ. PALLASII, *Pax.*

No. 259 *b.* Damp hollows in the "Taiga" or forest under the shade of *Abies sibirica* and *Populus suaveolens*, associated with grasses which had not begun to grow. Altitude 320 m., Kushabar.

Distribution (of var.). Ural and Caucasus Mts. to Armenia and N. Persia, *Pax & Knuth.*

PRIMULA ELATIOR, *Jacq.*

No. 469. Associated with stunted *Larix* and *Pinus* forests on dry rocky slopes, Japsa River, near the Bei Kem Rapids.

The flowers of this specimen agree with *P. Pallasii*, but the leaves, which are detached, do not agree with the Herbarium material. *P. Pallasii*, however, is poorly represented at Kew.

Distribution, England, central Europe to southern Russia.

PRIMULA ALGIDA, *Adams*, α. SIBIRICA, *Pax.*

No. 253. Peat bog at 300 m., Kalmakop, 40 versts W. of Minnusinsk.

PRIMULA ALGIDA, β. ARMENA, *Pax.*

No. 119. Alpine meadows and lake-shores above 2150 m., Lake Dolmo Kul, Upper Kobdo River, Great Altai Mts.

Distribution (of species). The Caucasus Mts., N. Persia, Turkestan, the Altai region, and Japan, *Pax & Knuth.*

PRIMULA NIVALIS, *Pall.*

No. 72. Boggy alpine meadows and by mountain-streams from 2450 to 2750 m., western Tannu-ola Mts. at the head of Saklya River.

Distribution. Caucasus Mts., Afghanistan, S. Siberia, Turkestan, and the Himalayas eastwards to Yunnan, *Pax & Knuth.*

ANDROSACE FILIFORMIS, *Retz.*

No. 294. Dry slopes in Poplar, Birch, and Spruce forests, Amil River.

Distribution. Eastern Europe throughout Siberia and in western North America, *Pax & Knuth.*

ANDROSACE SEPTENTRIONALIS, *Linn.*

No. 341. Dry banks in the Sistikem Valley, Vrianhai country.

Distribution. North-eastern Europe, northern Asia, and in N. America, *Pax & Knuth.*

CORTUSA MATTHIOLI, *Linn.* forma BROTHERI, *R. Knuth.*

In the shade of *Pinus sibirica* forest, Japsa River.

Distribution. Turkestan and the N.W. Himalayas, *Pax & Knuth.*

LYSIMACHIA THYRSIFLORA, *Linn.*

No. 440. In lakes in about 1 m. of water. Margin of Lake Todju Kul.

Distribution. Europe, throughout Siberia, and in temperate N. America. *Pax & Knuth.*

TRIENTALIS EUROPÆA, *Linn.*

No. 287. In swamps near Kushabar with *Sphagnum* and Birch; a true bog association.

Distribution. N. and central Europe, S. Siberia, Manchuria, and Japan, western N. America to Oregon, *Pax & Knuth.*

GLAUX MARITIMA, *Linn.*

No. 89. Marshes and lagoons on the dry side of desert lakes and also on lake-shores where submerged in spring, Uryu Nor and Achit Nor.

No. 428. Driest parts of open steppe between the flood-line of River Bei Kem and the Larch-forest zone.

Distribution. N. and central Europe, temperate Asia, and N. America, *Pax & Knuth.*

GENTIANEÆ.

GENTIANA ALGIDA, *Pall.*

No. 16. Dry summit of Kizil Taiga where the surface is even and not too rocky.

Distribution. The Altai, Mongolia, and Turkestan, *Kusnezow.*

GENTIANA ALTAICA, *Pall.*

No. 15. Dry summit of Mt. Kizil Taiga where not too rocky.

No. 336. From 1700 m. to the summit of the White Mountain in the Sayansk Mts. and near the River Arjanak.

Distribution. The Altai, N. Mongolia, and Turkestan, *Kuszenow.*

GENTIANA BARBATA, *Fröhl.*

No. 24. Dry peat in valley bottoms, Kindergay and Tula Rivers.

Distribution. Asia Minor, throughout Siberia and Turkestan.

GENTIANA DECUMBENS, *Linn.*

No. 478. Dry steppe at Dja Kul near the Ulu Kem and Djardan Rivers, on medium dry alluvium.

Distribution. S. and E. Siberia, N. Mongolia, the Himalayas and Thibet, *Kusnezow.*

GENTIANA PROSTRATA, *Hænke.*

No. 495. High upland meadows and shade of higher Larch forests at 1500 m. on dry peaty soil, Kizil Taiga.

Distribution. Eastern Alps in Europe, Siberia, Mongolia, and Turkestan and N.W. America, *Kusnezow.*

GENTIANA VERNA, *Linn.*, α. ANGULOSA, *Wahlenb.*

No. 348. Dry open places in forest or dry shady places associated with the surrounding steppe flora, Japsa and Sistikem Rivers.

Distribution. W. Europe, the Caucasus region, Siberia and Turkestan, *Kusnezow.*

PLEUROGYNE ROTATA, *Griseb.*

No. 106. Medium moist, well-drained alluvial silt, not far from streams or lakes, Achit Nor.

Distribution. Southern Siberia, Mongolia, Turkestan, China, Japan, and N. America.

SWERTIA OBTUSA, *Ledeb.*

Larch-forest shady association, Upper Yenisei Basin.

Distribution. The Altai, Mongolia, and Turkestan.

MENYANTHES TRIFOLIATA, *Linn.*

No. 271. Swamps and bogs on clumps of *Sphagnum*, Kushabar.

Distribution. Europe, N. Siberia, Japan, N. India, and N. America.

LIMNANTHEMUM NYMPHOIDES, *Link.*

No. 171. Stagnant backwaters of the Upper Irtish River.

Distribution. Europe, S. Siberia, Manchuria, China, N. Mongolia, and southwards into N.W. India.

POLEMONIACEÆ.

POLEMONIUM CÆRULEUM, *Linn.*

No. 406. Dry slopes in the open and steppe in the valley bottoms, Lower Kamsara River.

Distribution. Europe, southern and eastern Siberia, Turkestan, China, Japan, Kashmir, and in N. America.

BORAGINEÆ.

HELIOTROPIUM EUROPÆUM, *Linn.*

No. 182. Dry stony desert hills at an altitude of 600 m., Karin Nairn Hills, Upper Irtish basin.

Distribution. Southern Europe, N. Africa and the Canaries and Azores, Asia Minor and Persia, Australia, and in the south of the United States of America.

ECHINOSPERMUM LAPPULA, *Lehm.*

No. 488. On the edges of small streams and oases where not dried up in desert steppe, between Dja Kul and Djardan.

Distribution. Very widespread.

ANCHUSA MYOSOTIDIFLORA, *Lehm.*

No. 264. Universal and very common. Shade of Birch, Poplar, and Pine Forests and under Birch shade at the edges of cultivated land where not too swampy, near Kushabar in the Amil River forests.

Distribution. The Altai region.

PULMONARIA MONTANA, *Lej.*

No. 260. In the shade of Pine forests. Damp hollows in Pine and Birch groves on edges of cultivated land, river-banks under Willow scrub. Widely distributed all over the Amil River basin. One of the earliest spring plants.

Distribution. Central and southern Europe and southern and western Siberia, *Kerner.*

MYOSOTIS PALUSTRIS, *With.*

No. 388. Open steppe in valley bottoms and half-dried bogs, Shabash River.

Distribution. Europe, throughout Siberia, Persia, Afghanistan, and Turkestan, in Madeira and N. and Central America.

MYOSOTIS SYLVATICA, *Hoffm.*

No. 62. Mountain-sides from 2100 to 2900 m. where the soil is moist and peaty forming alpine meadows, or dry shady slopes where some soil has accumulated at the head of Saklya River.

No. 313. Open glades in *Pinus* and *Picea* forests, Petropolowsk.

Distribution. Very widespread throughout the Northern hemisphere.

ARNEBIA GUTTATA, *Bunge.*

No. 183. Dry stony desert hills at an altitude of 600 m., Karin Nairn Hills, Upper Irtish basin.

Distribution. Chinese Turkestan.

CONVOLVULACEÆ.

CONVOLVULUS ARVENSIS, *Linn.*, ε. SAGITTATUS, *Ledeb.*

No. 473. Dry steppe association near rivers on alluvium, Dja Kul on the Ulu Kem.

Distribution (of species). In temperate regions of both the New and Old World.

SOLANACEÆ.

SOLANUM PERSICUM, *Willd.*

No. 474. Dry steppe association near rivers, on alluvium near Dja Kul on the Ulu Kem.

Distribution. Asia Minor, Persia, southern Siberia, and in the Amur region.

SCROPHULARINEÆ.

LINARIA VULGARIS, *Mill.*

No. 472. Dry steppe association near rivers, on alluvium near Dja Kul on the Ulu Kem.

Distribution. Europe, N. Asia, and N. America.

DODARTIA ORIENTALIS, *Linn.*

No. 165. On alluvial and sandy plains at 750 m. and under. Medium dry conditions, near dry water-courses, and occasionally in moist places, Kemchik River near Sharasume.

Distribution. Asia Minor, Afghanistan, Turkestan, and Mongolia.

VERONICA INCANA, *Linn.*

No. 252 *c.* Edges of cultivated land bordering Birch and Pine forest. Soil very friable peaty sand, on rolling hills at 370 m., Kalmakof, 40 versts W. of Minnusinsk.

No. 420. Very common dry steppe plant. Dry sandy terraces of Bei Kem River and barren hill-sides, near the Ulu Kem and Kemchik Rivers, with southern aspect, and on almost desert plains.

Distribution. S. Europe, S. Siberia, N. Mongolia, and Turkestan.

VERONICA LONGIFOLIA, *Linn.*

No. 385. Open and dry steppe in valley bottoms, Upper Shabash River.

Distribution. N. and E. continental Europe, Siberia, Turkestan, Manchuria, and China.

VERONICA SERPYLLIFOLIA, *Linn.*

No. 290. Open meadows near Kushabar.

Distribution. Europe, the Azores, Kamtchatka, and Sachalin.

PEDICULARIS LONGIFLORA, *Rudolph.*

No. 23. In half-dry forest bogs, in valley bottoms, Kindergay and Tula valleys, and on mountain-sides, Bovashay Pass, Western Tannu-ola Mts.

Distribution. Baikal region and the Himalayas and Western Thibet, *Maximowicz.*

PEDICULARIS RESUPINATA, *Linn.*

No. 430. Shade of Larch forest near Upper Bei Kem and Dora Kem Rivers.

Distribution. Russia, throughout Siberia, Mongolia, N. China, Japan, and Korea and Sachalin, *Maximowicz.*

PEDICULARIS UNCINATA, *Steph.*

No. 370. Dry slopes of mountains in the Kandart Range up to 900 m.

Distribution. Siberia, *Maximowicz.*

PEDICULARIS COMOSA, *Linn.*, var. with red flowers.

No. 359. Moist alpine meadows (mid-season growth) or early growth on mountain-tops below snow and on southern slopes of the Sayansk Mts. and Upper Japsa systems.

Distribution. S.E. Europe, southern and eastern Siberia, N.W. Mongolia, and Manchuria, *Maximowicz.*

PEDICULARIS VERSICOLOR, *Wahlenb.*

No. 63. Mountain-sides above 2150 m. where the soil is either moist and peaty, forming alpine meadows, or dry shady slopes where some soil has accumulated. Western Tannu-ola Mts. and the mountains at the head of the Saklya River.

Distribution. N. and central Europe, Siberia, Turkestan, China and W. Himalayas, and N.W. America, *Maximowicz.*

LENTIBULARIÆ.

UTRICULARIA VULGARIS, *Linn.*

No. 92. Meadows and lagoons by the side of Achit Nor.

Distribution. Europe, Asia, N. Africa, and N. America.

SELAGINEÆ.

LAGOTIS GLAUCA, *Gärtn.*

No. 377. Summit of Mt. Ulug Taiga, dry patches on rocky boulders over 1800 m.

Distribution. Northern and southern Siberia, N. and N.W. Mongolia, and Turkestan.

LABIATÆ.

MENTHA SYLVESTRIS, *Linn.*, var.

No. 148. Cultivated parts of valleys near irrigation canals, Sharasume.

Distribution. Temperate regions in the Northern hemisphere.

THYMUS SERPYLLUM, *Linn.*

No. 417. Dry slopes in open and steppe in valley-bottoms, Lower Kamsara River.

Distribution. Very widespread.

NEPETA BOTRYOIDES, *Ait.*

No. 86. Stony desert under the driest vegetative conditions. Desert hills and barren valley-slopes of N.W. Mongolia.

Distribution. The Altai region and Western Thibet.

Some parts of the plant are covered by a white felt formed by a fungus.

NEPETA GLECHOMA, *Benth.*

No. 289. Open meadows near Kushabar.

Distribution. Europe, N. Asia, Asia Minor, and Persia.

DRACOCEPHALUM GRANDIFLORUM, *Linn.*

On the Sayansk Mts.

Distribution. N. Mongolia, Altai, Turkestan, and Baikal region.

DRACOCEPHALUM IMBERBE, *Bunge*.

No. 45. Mountain-sides above 2150 m. where the soil is either moist and peaty forming alpine meadows, or dry shady slopes where some soil has accumulated. Western Tannu-ola Mts. and the mountains at the head of the Saklya River.

Distribution. Turkestan, the Altai, and N. Mongolia.

DRACOCEPHALUM NUTANS, *Linn.*

No. 403. Dry slopes in the open, and steppes in valley bottoms, Lower Kamsara River.

Distribution. Southern Siberia, Turkestan, Kashmir, and northern India.

DRACOCEPHALUM RUYSCHIANA, *Linn.*

No. 384. Open and dry steppe in valley bottoms and on dry hill-slopes with desert flora, often in shade of Leguminous bushes. Upper Shabash and Bei Kem, also Kemchik basin and the south side of the western Tannu-ola Mts.

Distribution. Central Europe, the Caucasus, Irkutsk, the Altai, and Turkestan.

LEONURUS LANATUS, *Pers.*

No. 486. Flint and gravel desert between Dja Kul and Djardan in the Lower Kemchik basin.

Distribution. The Altai, Transbaikal region, S. Mongolia, and China.

LAMIUM ALBUM, *Linn.*

No. 302. In the open glades and in the shade of Spruce and Birch forests on the Amil River.

Distribution. Europe, southern Siberia, N. Africa, Persia, Asia Minor, China, Japan, and N. India.

PHLOMIS TUBEROSA, *Linn.*

No. 402. Dry slopes in the open and steppes in valley bottoms on the Lower Kamsara.

Distribution. S.E. Europe, Irkutsk, Dahuria, Turkestan, and Kashmir.

PLANTAGINEÆ.

PLANTAGO MAJOR, *Linn.*

No. 460. Driest part of valley steppe, Ulu Kem.

Distribution. Europe, Asia, N. America, and has spread with civilization.

PLANTAGO MARITIMA, *Linn.*

No. 459. Habitat the same as the preceding.

Distribution. Europe, Asia Minor, eastwards to Afghanistan, N. Asia, N. Africa, and in N. America.

CHENOPODIACEÆ.

CHENOPODIUM FRUTESCENS, *C. A. Mey.*

No. 84. In stony deserts under the driest vegetative conditions, Djardan Valley, Kemchik; also on the desert hills of N.W. Mongolia.

Distribution. Altai region.

CHENOPODIUM GLAUCUM, *Linn.*

No. 90 *a*. Marshes and lagoons by desert lakes and on lake-shores where submerged in spring, Uriu Nor and Achit Nor.

Distribution. World-wide.

EUROTIA CERATOIDES, *C. A. Mey.*, var. *β*. LATIFOLIA, *Bunge.*

No. 173. Medium dry conditions, sand-dunes and sandy silt-deposits just above the water-table in the Upper Irtish basin.

Distribution (of variety). Asia Minor and Turkestan.

CERATOCARPUS ARENARIUS, *Linn.*

No. 144. Stony desert on hill-sides at 750 m., Kran River Valley.

Distribution. S.E. Europe, Asia Minor, Persia, Altai, N. Mongolia, Afghanistan, and N.W. India.

CHENOLEA DIVARICATA, *Hook. f.*

No. 111. Dunes of blown sand in desert in the basin of Achit Nor.

Distribution. Mongolia, Kashmir, and western Thibet.

KOCHIA PROSTRATA, *Schrad.*, forma.

No. 39. Dry desert hill-slopes and upland valley plateaus up to 2150 m., western Tannu-ola Mts.

Distribution. S.E. Europe, Asia Minor, extending eastwards to China, from Transbaikal region southwards to Kashmir.

KALIDIUM ARABICUM, *Moq.-Tand.*

No. 191. Alluvial and gravel desert, Dzungarian Gap, Borotella plains.

Distribution. Transcaspian region and the Caucasus.

KALIDIUM FOLIATUM, *Moq.-Tand.*?

No. 93. Dry alluvial silt and sand-beds near the shore of Achit Nor, generally just above water-level.

Distribution. S. Russia, S. Siberia, and Turkestan.

KALIDIUM sp.?
No. 95. The same habitat and locality as the preceding.

SALICORNIA HERBACEA, *Linn.*
No. 94. Habitat the same as the preceding.
Distribution. Europe, temperate Asia and China.

SUÆDA MARITIMA, *Dumort.*
No. 90 *b*. Marshes and lagoons near Uriu Nor and Achit Nor and on lake-shores where submerged in spring.
Distribution. Europe, throughout Asia, and in Australia.

SUÆDA MICROPHYLLA, *Pall.*
No. 205. Low desert hills near Kara Daba Pass.
Distribution. Asia Minor, Transylvania, and Turkestan.

SALSOLA CRASSA, *Bieb.*, var. γ. SUBGLABRA, *C. A. Mey.*?
No. 180. Dry stony desert hills at 600 m., Karin Nairn Hills, Upper Irtish basin.
Distribution. Asia Minor, Transylvania, S.E. Persia, and Turkestan.

SALSOLA KALI, *Linn.*
No. 112. Dunes of blown sand in desert in the basin of Achit Nor.
No. 167. Stony and sandy desert under driest vegetative conditions, between 450 and 700 m., Kemchik and Kran Valleys, plains of Upper Irtish basin, and Dzungarian Gap.
Distribution. Europe, eastwards into China and Japan, Afghanistan, N. India, and Australia.

SALSOLA SPISSA, *Bieb.*
No. 169. Stony and sandy desert under driest conditions between 450 and 700 m., Kemchik and Kran Valleys, plains of Upper Irtish basin.
Distribution. Persia and Turkestan.

HALOXYLON AMMODENDRON, *Bunge.*
No. 168. Stony and sandy desert under driest conditions between 460 and 700 m.; plains of Kemchik and Kran Valleys and Upper Irtish basin.
No. 190. Open and stony desert, dry water-courses in desert hills from 300 to 900 m., near to Barlik on the east side of Dzungarian Gap, Karadaba Pass of Alatau Mts. and stony parts of Borotella plains.
Distribution. Transylvania, Altai, Turkestan, Afghanistan, and Baluchistan.

ANABASIS APHYLLA, *Linn.*

No. 201. Stony desert in the Dzungarian Gap.

Distribution. Southern Russia, Asia Minor, S.E. Persia, Turkestan, and Mongolia.

ANABASIS BREVIFOLIA, *C. A. Mey.*

No. 87. Stony desert under driest vegetative conditions, desert hills and barren valley steppes of N.W. Mongolia.

Distribution. Altai, western Mongolia, and Turkestan.

ANABASIS PHYLLOPHORA, *Kar. et Kir.*

No. 166. Stony and sandy deserts under the driest conditions between 450 and 700 m., Kemchik and Kran Valleys and on the plains of the Upper Irtish basin.

Distribution. Dzungaria and the Altai region.

NANOPHYTON CASPICUM, *Less.*

No. 209. Driest desert above irrigated land on the Borotella plains and near Dja Kul.

Distribution. Altai, N. Mongolia, and Turkestan.

HALOGETON ARACHNOIDEUS, *Moq.-Tand.*

Desert regions of N.W. Mongolia.

Distribution. Altai, N. Mongolia, and Turkestan.

POLYGONACEÆ.

ATRAPHAXIS LANCEOLATA, *Meisn.*

No. 487. Flint and gravel desert between Dja Kul and Djardan.

Var. DIVARICATA (*Ledeb.*), *Meisn.*

No. 145. Stony desert on hill-sides at 760 m. in the Kran River Valley.

Distribution (of species). Dahuria, Altai, Mongolia, and Turkestan.

POLYGONUM BISTORTA, *Linn.*

No. 47. Mountain-sides above 2100 m. where the soil is moist and peaty, forming alpine meadows, or on dry shady slopes where some soil has accumulated; at the head of the Saklya River.

No. 367. Highest mountain-tops 1950 m., very dry, Kandart Mts., also open steppe of Shabash Valley with dry flora.

Distribution. N. Europe and alpine regions in central Europe, eastwards through northern and central Asia to China and Japan, and N. America.

POLYGONUM POLYMORPHUM, *Ledeb.*, var. δ. UNDULATUM, *Ledeb.*

No. 383. Open and dry steppes in valley bottoms, Upper Shabash River.

Distribution (of variety). Southern Siberia.

POLYGONUM VIVIPARUM, *Linn.*

No. 48. Mountain-sides above 2150 m. where the soil is moist, forming alpine meadows, or on dry shady slope where some soil has accumulated. Western Tannu-ola Mts. at the head of the Saklya River.

Distribution. N. Europe, alpine districts throughout Siberia, Thibet, N.W. India, and N. America.

THYMELÆACEÆ.

DAPHNE MEZEREON, *Linn.*

No. 258. Damp hollows in the "Taiga" or forest associated with grasses under the shade of *Abies sibirica* and *Populus suaveolens.* Forests round Kushabar at 320 m.

No. 309. Shade of Poplar and Spruce on the Amil River.

Distribution. Europe and Asia Minor.

No. 309 has neither flowers nor fruit, but is most probably *D. Mezereon.*

ELÆAGNACEÆ.

HIPPOPHAË RHAMNOIDES, *Linn.*

No. 498. On sandy shingle by the banks of the Lower Kemchik River associated with *Populus suaveolens.*

Distribution. Europe and temperate Asia.

EUPHORBIACEÆ.

EUPHORBIA ALPINA, *C. A. Mey.*

No. 320. Above 600 m. in open glades and meadows of *Abies sibirica* forest on the Amil River.

Distribution. The Caucasus and Altai regions and Irkutsk.

EUPHORBIA LUTESCENS, *C. A. Mey.*

Distribution. The Altai and Dzungaria.

EUPHORBIA near E. SUBCORDATA, *C. A. Mey.*

No. 78. Barren desert hills at 1500 m., Kundi Kureen and Kundi Kalan Rivers.

URTICACEÆ.

ULMUS TURKESTANICA, *Regel.*

No. 187. Gardens and streets, Chuguchak.

Distribution. Turkestan.

There are probably other forms which may be placed under *U. turkestanica*, in which case the distribution would be somewhat wider.

CANNABIS SATIVA, *Linn.*

No. 162. Cultivated and irrigated fields, Sharasume.

Distribution. Cultivated in many parts of the world.

URTICA DIOICA, *Linn.*

No. 466. Associated with stunted Larch and Pine forest on dry rocky slopes, Japsa Mts. near the Bei Kem rapids.

Distribution. Very widespread.

CUPULIFERÆ.

BETULA GLANDULOSA, *Mich.*

No. 358. Half-dry steppe-like valley bottoms and mountain-slopes up to the snow-line where it is not moist. Japsa Valley, Tashkel Mts., and Upper Kandart Range.

Distribution. N. America: Greenland southwards to New California; N.E. Siberia and the Altai, *H. Winkler.*

BETULA PUBESCENS, *Ehrh.*, var. δ. TORTUOSA, *Winkl.*

No. 73. By river-sides on shingle and sand associated with Larch and Poplar, Lower Bogdhon River.

Distribution. Altai.

ALNUS ALNOBETULA, *Hartig*, var. β. FRUTICOSA, *Winkl.*

No. 323. On gravelly banks of the River Amil above Chuknok Ridge.

Distribution. Throughout Siberia, Japan, N. America, *H. Winkler.*

SALICINEÆ.

SALIX ARBUSCULA, *Linn.*

No. 352. Open steppe in the bottom of the Japsa River Valley.

Distribution. Europe, alpine regions in Scandinavia, Scotland and Switzerland, Asia Minor, Dahuria, Altai, and Greenland.

SALIX BERBERIFOLIA, *Pall.*

No. 399. Mountain-sides from 1200 to 1800 m., Sayansk Mts., Upper Japsa and Kandart Valleys.

Distribution. Dahuria and the Altai region.

SALIX CAPRÆA, *Linn.*

No. 319. Upper part of the Spruce forest and on the sides of the Sayansk Mts., also on the banks of the Amil River.

Distribution. Europe, central and northern Asia, Asia Minor, Persia extending eastwards to the Himalayas in N.W. India, *Anderson.*

SALIX PENTANDRA, *Linn.*

No. 107. By the streams and lagoons round Achit Nor.

Distribution. Europe ; Asia : Turkestan, Dahuria and Kamtchatka, *Anderson.*

SALIX PURPUREA, *Linn.*

No. 483. By streams and irrigation canals on dry steppe and alluvial soils, Dja Kul and Ulu Kem.

Distribution. Europe, Asia Minor, N. Africa, Altai, and Turkestan.

SALIX SIBIRICA, *Linn.*, var. *β.* SERICEA, *Ledeb.*?

North-West Mongolia.

Distribution. Altai and Dzungaria.

SALIX VIMINALIS, *Linn.*

No. 22. Banks of the Djardan River.

No. 256 ♂. "Taiga" or open Pine forest in the shade on hill-slopes associated with grasses at 320 m. above sea-level, near Kushabar.

No. 261 ♀. Rivers and streams near Kushabar.

Distribution. Throughout Europe and Siberia and in Dzungaria.

POPULUS ALBA, *Linn.*, var. *β.* NIVEA, *DC.*

No. 177. On the banks of the Upper Irtish River.

Distribution. Central and S. Europe eastwards to the Caucasus and in W. Central Asia, *C. K. Schneider.*

POPULUS SUAVEOLENS, *Fisch.*

No. 292. On the banks of the Amil River and wet places near Kushabar.

Distribution. W. Siberia, Turkestan, Mongolia, and Manchuria, *C. K. Schneider.*

GNETACEÆ.

EPHEDRA spp.

No. 412 *a.* Dry sandy river terraces on the Kamsara River, also on the Upper Bei Kem.

This plant is probably *E. monosperma*, G. S. Gmel., but there is insufficient material for determination.

No. 412 *b.* This specimen may be *E. distachya*, Linn., but there are no flowers and fruit on this specimen.

CONIFERÆ.

JUNIPERUS COMMUNIS, *Linn.*

No. 133. Larch-forest zone from 1800 to 1950 m., Great Altai Mts. and Kran River.

No. 329. Rocky slopes at an altitude of 900 m. with southern aspect on the Sayansk Mts. at the source of the Amil River.

Distribution. Europe, Siberia, Mongolia, Kashmir, N.W. India, and N. America.

JUNIPERUS PSEUDO-SABINA, *Fisch. et Mey.*

No. 75. Dry rocky mountain-slopes at 2450 m., western Tannu-ola Mts. at the head of the Saklya River.

Distribution. Turkestan and Thibet.

JUNIPERUS SABINA, *Linn.*

No. 134. Mountain-sides from 1800 to 2900 m., Great Altai Mts., Kran River, and Upper Irtish.

Distribution. Asia Minor and Turkestan.

PICEA OBOVATA, *Ledeb.*

No. 132. Shade of Larch forest (sub-dominant) 900 to 1950 m., Kran River, Gt. Altai Mts.

No. 279. Specimens from young tree [glabrous]. Moist but not water-logged hollows near rivers, Kushabar.

No. 280. Specimens from old tree [stem hairy]. Hab. as the preceding.

Distribution. The Altai and the Amur region.

PICEA SCHRENKIANA, *Ant.*

No. 207. Taiki Pass, Tian Shan.

Distribution. Dzungaria.

PINUS CEMBRA, *Linn.*, var. SIBIRICA, *Loud.*

No. 263. Northerly shaded slopes of hills associated with *Populus suaveolens*, Birch, and *Abies sibirica*. In the Upper Amil River basin near Kushabar.

No. 305. Half-swampy or well-drained land associated with *Picea obovata*, *Abies sibirica*, Mosses, Lichens, and *Lycopodium*; Amil River between Kushabar and Petropolowsk.

Specimen with no number. W. Tannu-ola Mts.

Distribution (of variety). The Altai region.

Pinus sibirica, Mayr.

ABIES SIBIRICA, *Ledeb.*

No. 270*a*. Moist sunless hollows or shade under Pines in forests, Kushabar.

Distribution. The Altai Mts. and Turkestan eastwards to China, from Irkutsk province southwards to Thibet.

LARIX SIBIRICA, *Ledeb.*

No. 343. Sistikem River.

No. 355. Shade of *Picea* and *Pinus* forest from 900 to 1200 m., Upper Japsa River, Sistikem. Also from the Kobdo River.

Distribution. The Altai Mts., Okhotsk region, and Manchuria.

MONOCOTYLEDONES.

ORCHIDACEÆ.

CYPRIPEDIUM MACRANTHON, *Sw.*

No. 409. Natural meadows by the side of the Lower Kamsara River and under the shade of scattered Larch.

Distribution. S. and E. Siberia and in China.

ORCHIS MILITARIS, *Linn.*

No. 368. Dry slopes of Kandart Range up to 900 m.

Distribution. Throughout Europe and western and southern Siberia.

IRIDEÆ.

IRIS ENSATA, *Thunb.*

No. 114. Medium dry loam in valley bottoms and shores of lakes, Achit Nor basin.

No. 178. Edges of marshes and oases in plateau desert, Kobdo Valley.

No. 475. Dry steppe association near rivers on alluvium, Dja Kul and Ulu Kem.

Distribution. Dahuria, Mongolia, and Afghanistan eastwards to China.

IRIS RUTHENICA, *Ait.*

No. 272. Shade of *Pinus* forests, medium moist soil, Kushabar.

Distribution. Throughout central Asia from Transylvania to Japan.

LILIACEÆ.

MAIANTHEMUM BIFOLIUM, *DC.*

No. 317. Shade of *Pinus*, *Picea*, Birch and Poplar "Taiga," and also open glades, Amil River.

Distribution. Europe, N.E. Siberia, Mongolia, China, Japan, and N America.

HEMEROCALLIS FLAVA, *Linn.*

No. 464. Dry valley steppe near the Ulu Kem River where the ground is occasionally flooded.

Distribution. Europe, the Tyrol ; Asia : Irkutsk, China, and Japan.

ALLIUM MONADELPHUM, *Turcz.*

No. 43. Mountain-sides above 2150 m. where the soil is either moist and peaty, forming alpine meadows, or on dry shady slopes where some soil has accumulated. North and south slopes of the western Tannu-ola Mts. at the head of the Saklya River.

Distribution. S. Siberia and Turkestan, *Regel.*

ALLIUM SCHŒNOPRASUM, *Linn.*

No. 423. In the moist shady places of the forest on both sides of the Sayansk Mts., from Kushabar to the Bei Kem.

Distribution. Europe, central Asia, and N. America, *Regel.*

ALLIUM FISTULOSUM, *Linn.*

No. 117. Between 2150 and 2450 m. on sandy slopes with alpine vegetation or on plateau deserts along torrent water-courses, Kundelun Mts. and Suok and Upper Kobdo Valleys.

Distribution. The Altai, Dahuria and Baikal regions, in Siberia and Turkestan, *Regel.*

ALLIUM SALESOVI, *Regel* in Act. Hort. Petrop. iii. II (1875), p. 140, sub *A. senescente*, Linn., δ. *brevipedicellato*, Regel.

Herba bulbis elongatis-ovoideis rhizomati repenti insidentibus tunicis membranaceis integerrimis. *Folia* anguste linearia, obtusa, 3–8 cm. longa, 0·15 cm. lata, margine papilloso-scaberula. *Scapi* erecti, 4–6 cm. alti, angulati ; spatha bivalvis ; valvæ rotundæ, 0·4 cm. longæ, membranaceæ ; umbellæ ad 1·5 cm. latæ, hemisphæricæ, capsuliferæ ; pedicelli ad 0·4 cm. longi, basi nudi. *Perigonii phylla* sicco rosea, oblonga, obtusa, ad 0·5 cm. longa, 0·25 cm. lata, subdenticulata. *Filamenta* 0·7 cm. longa, perigonium multo superantia, simplicia, basi dilatata.

A. sessiliflorum, Fisch. in herb. Stephan. ex Regel, l. c.

No. 18. Mountain-tops and slopes of the Kizil Taiga where the peaty or gravelly soil is moist or dry, Lower Kemchik River, N.W. Mongolia.

Regel appears to have seen incomplete specimens of this plant collected by Salesov in the Altai. He places them under *A. senescens*, Linn., var. δ. *brevipedicellatum*, but mentions that they may constitute a distinct species, for which he suggests the name *A. Salesovi.*

ALLIUM STELLERIANUM, *Willd.*

No. 493. On driest hill-slopes and valley bottoms, sandy and gravelly places, Dja Kul and Djardan.

Distribution. Altai, Baikal, and Turkestan, *Regel.*

ALLIUM SZOVITSI, *Regel.*

No. 66. Mountain-sides above 2150 m. where the soil is either moist and peaty, forming alpine meadows, or dry shady slopes where some soil has accumulated. Western Tannu-ola Mts. at the head of the Saklya River.

Distribution. The Caucasus and Altai Mountains, *Regel.*

ALLIUM VICTORIALIS, *Linn.* ?

No. 332. In the shade of the *Abies* forest up to 1400 m. on mountains; also lower Taiga in moist places. N. and S. Sayansk Mts. and Kushabar.

Distribution. Southern and central continental Europe, Siberia, Japan, N.W. China, mountains in N.W. India and in N.W. America, *Regel.*

There are no flowers or fruit to this specimen, the leaves and root however match *A. Victorialis.*

LILIUM MARTAGON, *Linn.*

No. 369. Dry slopes of the Kandart Range up to 900 m.

Distribution. Central and southern Europe, Siberia and Japan, *Waugh.*

TULIPA UNIFLORA, *Bess.*

No. 251. One of the earliest steppe plants, Minnusinsk.

Distribution. Altai and Dzungaria.

ERYTHRONIUM DENS-CANIS, *Linn.*

No. 353. Dry steppe in open valley bottoms, Japsa and Sistikem Rivers.

Distribution. Central and southern Europe, Siberia, Korea and Japan.

The native name is "*Kandick*"; it is used for food by the Urian-Hai tribes or Soiots in the Upper Yenisei basin.

LLOYDIA SEROTINA, *Griseb.*

No. 363 *b.* Dry summits of Sayansk Mountains in Upper Kandart and Japsa systems, associated with Reindeer Moss.

Distribution. Alpine districts in Europe, N. Asia, China, N.W. India, Thibet, and N. America, *Berger.*

PARIS QUADRIFOLIA, *Linn.*, var. OBOVATA, *Regel et Til.*

No. 274. Shade of Birch, Spruce, and Poplar forests on slopes near Kushabar and Amil River.

Distribution (of variety). Southern Siberia, China, Japan, and Manchuria, *Franchet.*

VERATRUM ALBUM, *Linn.*

No. 357. Moist alpine meadows up to 1800 m. just under the snow-line, moist forest-glades and edges of swamps. Very common. Amil River from Kushabar to the Sayansk Mts., also southern slopes of these mountains.

Distribution. Switzerland, N. Russia, Siberia, China, Japan, and Canada.

VERATRUM NIGRUM, *Linn.*

No. 433. Dry rocky slopes round Lake Todju Kul.

Distribution. Central and S. Europe, Dahuria, E. Thibet, China, Japan, and Manchuria.

JUNCACEÆ.

JUNCUS GERARDI, *Loisel.*

No. 99. Marshes and natural water-meadows by rivers, streams, and lakes, Achit Nor.

Distribution. Europe, central Asia to China, N.W. Africa, and N. America, *Buchenau.*

ALISMACEÆ.

BUTOMUS UMBELLATUS, *Linn.*, var. β. MINOR, *Turcz.*

No. 471. Dry steppe association near rivers, on alluvium near Dja Kul on the Ulu Kem.

Distribution (of var.). Asia: Kashmir and Transbaikal, *Buchenau.*

NAIADACEÆ.

TRIGLOCHIN MARITIMUM, *Linn.*

No. 196. Alluvial desert, Dzungarian Gap.

Distribution. Northern hemisphere and S. America to Tierra del Fuego, *Buchenau.*

TRIGLOCHIN PALUSTRE, *Linn.*

No. 98. Marshes and natural water-meadows by rivers, streams and lakes, Achit Nor.

Distribution. Northern hemisphere and S. America, *Buchenau.*

POTAMOGETON PECTINATUS, *Linn.*

No. 4. On the shores of lakes, Sul Kul, Lower Kemchik.

Distribution. Europe, Asia, N. and S. America, Africa, and Australia, *Ascherson & Græbner.*

CYPERACEÆ.

SCIRPUS CÆSPITOSUS, *Linn.*

No. 398. Mountain-sides from 1200 to 1800 m. of the Sayansk Range, Upper Japsa and Kandart systems.

Distribution. Europe, Sachalin and Japan, N. and S. America.

ERIOPHORUM GRACILE, *Koch.*

No. 275. Tops of *Sphagnum* tufts in swamps near rivers, Kushabar.

Distribution. Europe, Japan, and N. America, *C. B. Clarke.*

ERIOPHORUM SCHEUCHZERI, *Hoppe.*

No. 44. Bogs on mountain-sides from 2100 to 2740 m., W. Tannu-ola Mts. and on the mountains at the head of the Saklya River.

Distribution. N. and central continental Europe, arctic Siberia, Turkestan, Kashmir, Japan, and arctic N. America, *C. B. Clarke.*

ERIOPHORUM VAGINATUM, *Linn.*

No. 285. In Heath association on half-dried swamps under Birch and Pine, Kushabar.

No. 364. Swampy places on the sides of the Sayansk Mts. in the Upper Japsa and Kandart systems.

Distribution. Europe, Siberia, Turkestan, Japan, and N. America, *C. B. Clarke.*

CAREX RIGIDA, *Gooden.*

No. 8. Dry mountain-summits where not too rocky and where the surface is even, on the Kizil Taiga.

Distribution. Arctic and alpine regions in Europe, N. Asia, and arctic America, *Kükenthal.*

CAREX CÆSPITOSA, *Linn.*, var. MAGIS-BRACTEATA, *C. B. Clarke*; *cf.* Bull. Misc. Inf., Add. Ser. viii. p. 70.

No. 102. Medium moist, well-drained alluvial silt not far from streams or lakes, Achit Nor.

Distribution. Dahuria, Amur, and Ussuri, *C. B. Clarke.*

CAREX MELANANTHA, *C. A. Mey.*

No. 58. Mountain-sides above 2150 m. where the soil is either moist and peaty, forming alpine meadows, or dry shady slopes where some soil has accumulated. Western Tannu-ola Mts. at the head of the Saklya River, especially in alpine meadows.

Distribution. Alpine regions in central Asia, Turkestan, Altai, Baikal, Pamir, Kashmir, and Afghanistan, *Kükenthal.*

Carex atrata, *Linn.*

No. 382. Summit of Ulug Taiga, dry patches on rocky boulders over 1800 m. alt.

Distribution. Arctic alpine Europe, N. coast and inland mountain-ranges in Siberia, Altai, and Tian Shan and N. America, *Kükenthal.*

Carex pediformis, *C. A. Mey.*

No. 257 *c.* "Taiga" or forests of Pine, Birch, Poplar, and Spruce round Kushabar, and the Amil River.

No. 306. Shade of Poplar, Birch, and Spruce, rather dry habit, not common.

Distribution. Throughout Siberia, Manchuria, and N. China, *Kükenthal.*

Carex capillaris, *Linn.*

No. 7. Dry mountain-summit of Kizil Taiga where it is not too rocky and the surface is even.

No. 103. Medium moist, well-drained alluvial silt not far from streams or lakes, Achit Nor.

Distribution. Europe, alpine and sub-alpine regions: Asia, Turkestan, Siberia, Kamtchatka, and Manchuria; North America, *Kükenthal.*

Carex Regeli, *B. et O. Fedtsch.*; *cf.* Bull. Misc. Inf., Add. Ser. viii. p. 151.

No. 101. Medium moist, well-drained alluvial silt not far from streams or lakes, Achit Nor.

Distribution. Mongolia, Turkestan, Dahuria, Pamir, Kashmir, and N.W. India, *C. B. Clarke.*

Carex sp.

No. 441. Margin of Lake Todju Kul.

There are no ripe nuts on this specimen.

GRAMINEÆ.

Panicum miliaceum, *Linn.*

No. 497 *a.* Grown on irrigated land in Djardan Valley.

Setaria glauca, *Beauv.*

No. 149. Cultivated part of valleys near irrigation canals, Sharasume.

Distribution. World-wide.

Setaria italica, *Beauv.*

No. 160. Cultivated and irrigated fields, Sharasume, Kran River, and Upper Irtish.

Distribution. Tropical and subtropical regions and cultivated.

SETARIA VIRIDIS, *Beauv.*

No. 161. Cultivated and irrigated fields, Sharasume, Kran River, and Upper Irtish.

No. 470. Associated with stunted *Larix* and *Pinus* forests on dry rocky slopes, Japsa Mts. near Bei Kem rapids.

Distribution. World-wide.

ANDROPOGON ISCHÆMUM, *Linn.*

No. 150. Cultivated part of valleys near irrigation canals, Sharasume.

Distribution. Temperate and tropical regions of Europe, Asia, and Africa, N. America and Western Australia.

HIEROCHLOA ALPINA, *Roem. & Schult.*

No. 363 *a*. Dry mountain-summits associated with Reindeer Moss, Sayansk Mts. and in Upper Kandart and Japsa systems.

Distribution. Arctic and alpine regions in the Northern hemisphere and in New Zealand.

STIPA CAPILLATA, *Linn.*

No. 76. Barren desert hills under the driest floral conditions from valley bottoms up to the desert plateaus at 2100 m. It is the commonest grass and is grazed by Mongol flocks. Deserts of N.W. Mongolia.

No. 186. Medium dry alluvial plains at 490 to 600 m., Dzungarian plains near Chuguchak.

No. 197. S. side of Dzungarian Gap.

No. 491. Common in sandy or gravelly valleys, Dja Kul and Djardan.

Distribution. E. and central Europe, Turkestan, Dahuria, Altai, N. China, and N.W. Himalayas.

STIPA SPLENDENS, *Trin.*

No. 477. Dry steppe near rivers where rarely flooded, very common grass-food for Soiot herds, Dja Kul.

Distribution. S. Siberia, Turkestan, Mongolia, W. Thibet, and Kashmir.

CALAMAGROSTIS EPIGEIOS, *Roth.*

No. 254 *b*. In open Pine and Birch forest or "Taiga," Kalmakof, 40 versts W. of Minnusinsk.

Distribution. Temperate Europe and Asia from the Mediterranean to the Arctic regions.

AGROSTIS VULGARIS, *Linn.*?

No. 100. Marshes and natural water-meadows near rivers, streams, Achit Nor.

Distribution. Europe, Asia Minor, and N. America.

AGROSTIS ALBA, *Linn.*

No. 455. Driest part of the Ulu Kem valley-steppe.

Distribution. Europe, N. Asia, N. Africa, N. and S. America, Australia and New Zealand.

DEYEUXIA LAPPONICA, *Kunth.*

No. 6. Dry mountain-summit of the Kizil Taiga where the surface is even and not too rocky.

Distribution. Arctic Europe, Altai, Baikal and Yenisei regions, and in N. America.

PHRAGMITES COMMUNIS, *Trin.*

No. 97. Fresh-water lagoons on edges of desert lakes, Achit Nor.

No. 129. Southern aspects from 900 to 1700 m. in the neighbourhood of streams and under rather moist conditions, southern Great Altai Mts., upper Kran River.

Distribution. World-wide.

CATABROSA AQUATICA, *Beauv.*

No. 31. Margins of swamps or small lakes. Immersed in water, Tula River.

Distribution. Temperate regions of the N. hemisphere and in S. America.

MELICA NUTANS, *Linn.*

No. 327. Upper Amil River.

Distribution. Europe and N. Asia, extending southwards into Asia Minor and Kashmir.

POA ALTAICA, *Trin.*

No. 396. Shade of Larch and Scotch Pine in valley bottoms of Shabash and Kamsara Rivers.

Distribution. The Altai region.

POA PRICEI, *N. D. Simpson*, sp. n. (Pl. **23.** figs. 4–12.)

Affinis *P. macrocalyci*, Trautv. et Mey., sed panicula compactiore, glumis minoribus nec acuminatis, pedicellis lævibus, foliis supra subtusque glabris distincta.

Culmi 35 cm. alti, geniculati, rigidi, læves, glauci, basi vaginis vetustis obtecti. *Foliorum laminæ* subglaucæ, lineares, acutæ, curvatæ, rigidæ, 4–8 cm. longæ, 0·5 cm. latæ, præter margines et carinam asperulas læves, plicatæ vel explanatæ; ligulæ ovatæ 0·1–0·3 cm. longæ, hyalino-scariosæ; vaginæ quam foliorum caulinorum laminæ multo longiores, superne carinatæ, glabræ, læves, valde striatæ. *Panicula* erecta compacta, 7 cm. longa; ram læves; spiculæ ellipticæ, 3–7-floræ, 0·7 cm. longæ; pedicelli 0·1 cm. longi. *Glumæ* ovatæ, acutæ, læves, inferior sub-2-nervis, superior paullo longior 3-nervis, inferne ciliata. *Valvæ* oblongæ, acutæ, rigidæ, 5-nerves, basin versus in dorso et ad margines lanato-pilosæ. *Paleæ* quam valvas paullo breviores, carinis scabris.

No. 74. In oasis meadows in the desert-plateau valley of the Saklya River, Mongolia.

DACTYLIS GLOMERATA, *Linn.*

No. 130. Southern aspects from 900 to 1700 m. in South Great Altai Mts., Upper Kran River.

Distribution. World-wide.

FESTUCA OVINA, *Linn.*

No. 210. Desert hills above 900 m. and downs at 2750 m., Borotella Pass, Tian Shan.

Distribution. Arctic and temperate regions of the Northern hemisphere.

BROMUS INERMIS, *Leyss.*

No. 492. Common desert plant on driest hill-slopes and valley-bottoms, sandy or gravelly, Dja Kul and Djardan Valleys.

Distribution. Continental Europe, N. Asia, and as far south as N.W. India.

AGROPYRON CRISTATUM, *Roem. & Schult.*

No. 77. Barren desert hills where driest floral conditions prevail, from valley-bottoms at 1500 m., N.W. Mongolia.

No. 419. River terraces and driest parts of open steppe between flood-line of Kamsara and Upper Bei Kem Rivers and the Larch-forest zone.

Distribution. S.E. Europe, Asia Minor, Persia, Afghanistan, the Altai, and Turkestan.

TRITICUM VULGARE, *Linn.*

No. 497 *b.* Grown on irrigated land in the Djardan Valley.

HORDEUM PRATENSE, *Linn.*

No. 104. Medium moist, well-drained alluvial silt not far from streams and lakes Achit Nor.

No. 426. Driest parts of the open steppe between the flood-line of the river and the Larch-forest zone, Upper Bei Kem and Dora Kem.

Distribution. Europe, N. Asia, N. America, and the Cape of Good Hope.

HORDEUM VULGARE, *Linn.*

No. 497 *c.* Grown on irrigated land in the Djardan Valley.

ELYMUS DASYSTACHYS, *Trin.*

No. 116. Stony deserts on hill-sides and in plateau valleys up to 2050 m. under the driest vegetative conditions. In the Suok Valley and on the N. side of the Great Altai Range.

No. 453. Dry valley steppe, alluvial soil often where flooded and where there is a little moisture, on the banks of the Ulu Kem.

No. 453 agrees in structure with *E. dasystachys*, but the plant is remarkable for its slender form and its one-flowered spikelets.

Distribution. Siberia, Mongolia. Turkestan, China, Japan, Pamir, and N.W. India.

ELYMUS GIGANTEUS, *Vahl.*

No. 176. Medium dry conditions, sand dunes and sandy silt deposits just above the water-table; sandy plains of the Upper Irtish basin.

Distribution. Russia and the Altai region.

PTERIDOPHYTA.

FILICINEÆ.

NEPHRODIUM SPINULOSUM, *Desv.* ?

No. 308 *a*. *Picea* and *Pinus* forests under the wettest conditions, belonging to the typical Amil River flora.

This specimen and the following are too young for certain identification.

NEPHRODIUM SPINULOSUM, *Desv.*, var. DILATATUM, *Hook.* ?

No. 308 *b*.

Distribution (of species). Europe, Asia, Eastern Himalayas, and N. America, *Christensen.*

CYSTOPTERIS FRAGILIS, *Linn.*

No. 312. On a basalt cliff, Amil River, Petrapolowsk. Used by the Russians for medicinal purposes.

Distribution. Arctic, antarctic, and temperate regions and alpine tropical regions, *Christensen.*

POLYPODIUM DRYOPTERIS, *Linn.*

No. 308 *c*.

Distribution. Europe, Asia, W. America, arctic and temperate regions, *Christensen.*

LYCOPODIACEÆ.

LYCOPODIUM ANNOTINUM, *Linn.*

No. 308 *d*.

Distribution. Arctic zones and mountains of the N. temperate zone in both hemispheres, *Baker*.

SELAGINELLACEÆ.

SELAGINELLA SANGUINOLENTA, *Spring.*

No. 482. Very dry rocky hill-slopes, in an almost desert flora, Dja Kul.

Distribution. E. Siberia, *Baker*.

BRYOPHYTA.

MUSCINEÆ.

SPHAGNUM ACUTIFOLIUM, *Ehrh.*

No. 286 *a*. In Heath-association in half-dried swamps under Birch and Pine, Kushabar.

Distribution. Arctic, subarctic, and temperate Europe, subarctic America and Atlantic N. America, Siberia, Japan, and Sikkim Himalayas, *Warmstoff*.

LICHENES.

PLATYSMA JUNIPERARUM, *Nyl.*

No. 70. Alpine meadows above 2100 m. and rocky slopes and screes up to 3000 m., W. Tannu-ola Mts. south of the Saklya River.

Distribution. Northern parts of the Northern hemisphere.

STICTA PULMONARIA, *Ach.*

No. 286 *b*. In Heath-association in half-dried swamps under Birch and Pine, Kushabar.

Distribution. Very widespread.

USNEA LONGISSIMA, *Ach.*

No. 270 *b*. Moist sunless hollows or in shade under Pines in forests near Kushabar.

Distribution. Widespread in the Northern hemisphere.

EXPLANATION OF THE PLATES.

PLATE 20.

Sketch-Map showing the route taken by Mr. Price through N.W. Mongolia and Dzungaria and the localities mentioned in the paper; based upon the map in the Geographical Journal, vol. xxxix. (June 1912), by permission of the Royal Geographical Society.

PLATE 21.

Figs. 1–7. SAUSSUREA PRICEI, N. D. Simpson.

1. Plant (nat. size). 2. Floret, × 4. 3. Anthers, × 5. 4. Stigma, × 15. 5 and 6. External and internal involucral scales, × 2. 7. Seta from the receptacle, × 6.

Figs. 8–14. LATHYRUS FROLOWII, N. D. Simpson.

8. Plant (nat. size). 9. Vexillum, × 3. 10. Ala, × 3. 11. Carina, × 3. 12. Stamens and ovary, × 3. 13. Calyx, × 3. 14. Leaf-margin, highly magnified.

PLATE 22.

Figs. 1–7. SAUSSUREA PSEUDO-ALPINA, N. D. Simpson.

1. Plant (nat. size). 2. Floret, × 3. 3. Anthers, × 5. 4. Stigma, × 5. 5 and 6. Internal and external involucral scales, × 3. 7. Seta from the receptacle, × 3.

Figs. 8–12. SENECIO PRICEI, N. D. Simpson.

8. Plant (nat. size). 9. Disc floret, × 4. 10. Ray floret, × 2. 11. Anthers, × 10. 12. Stigma, × 25.

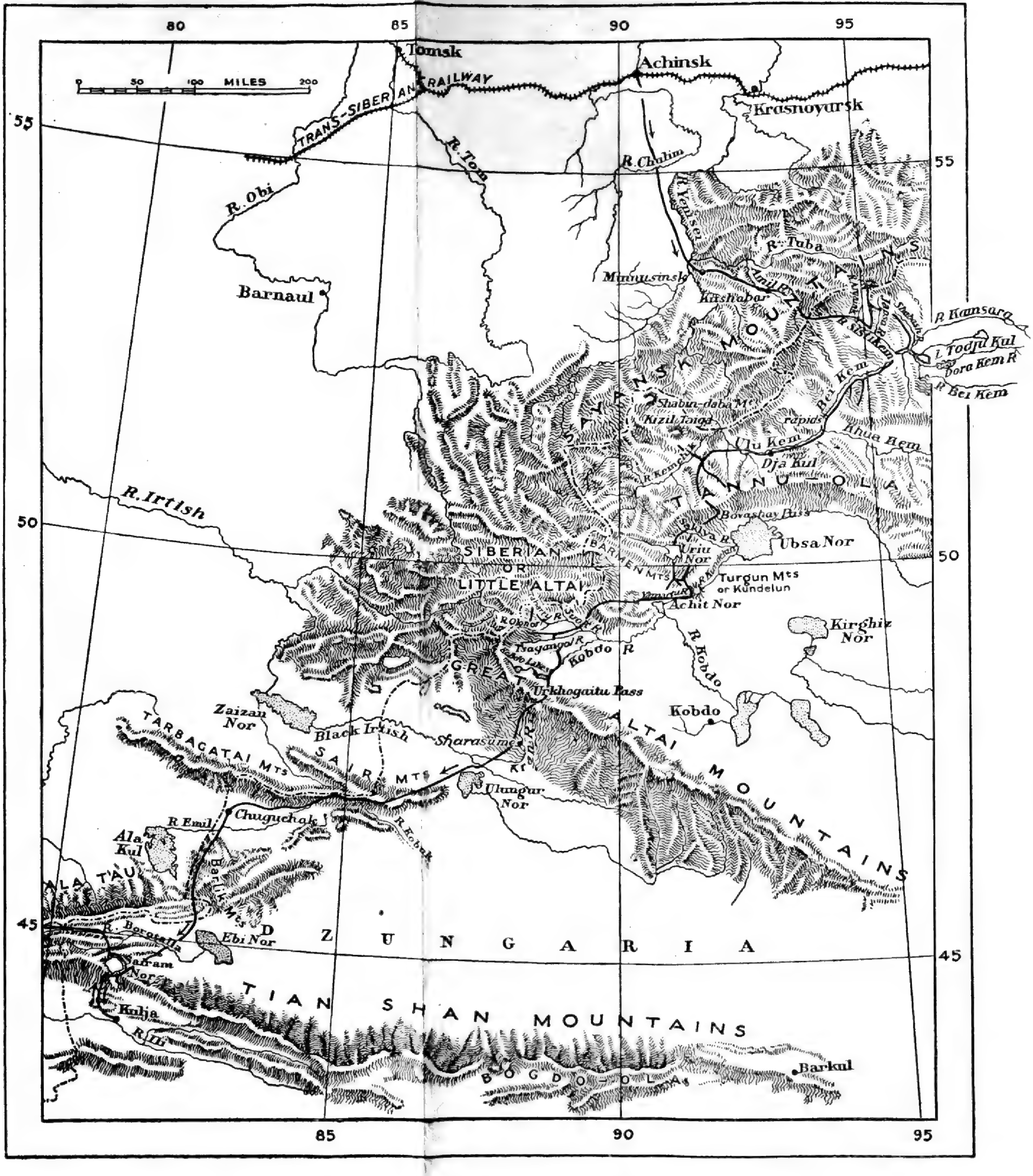
PLATE 23.

Figs. 1–3. PEUCEDANUM PRICEI, N. D. Simpson.

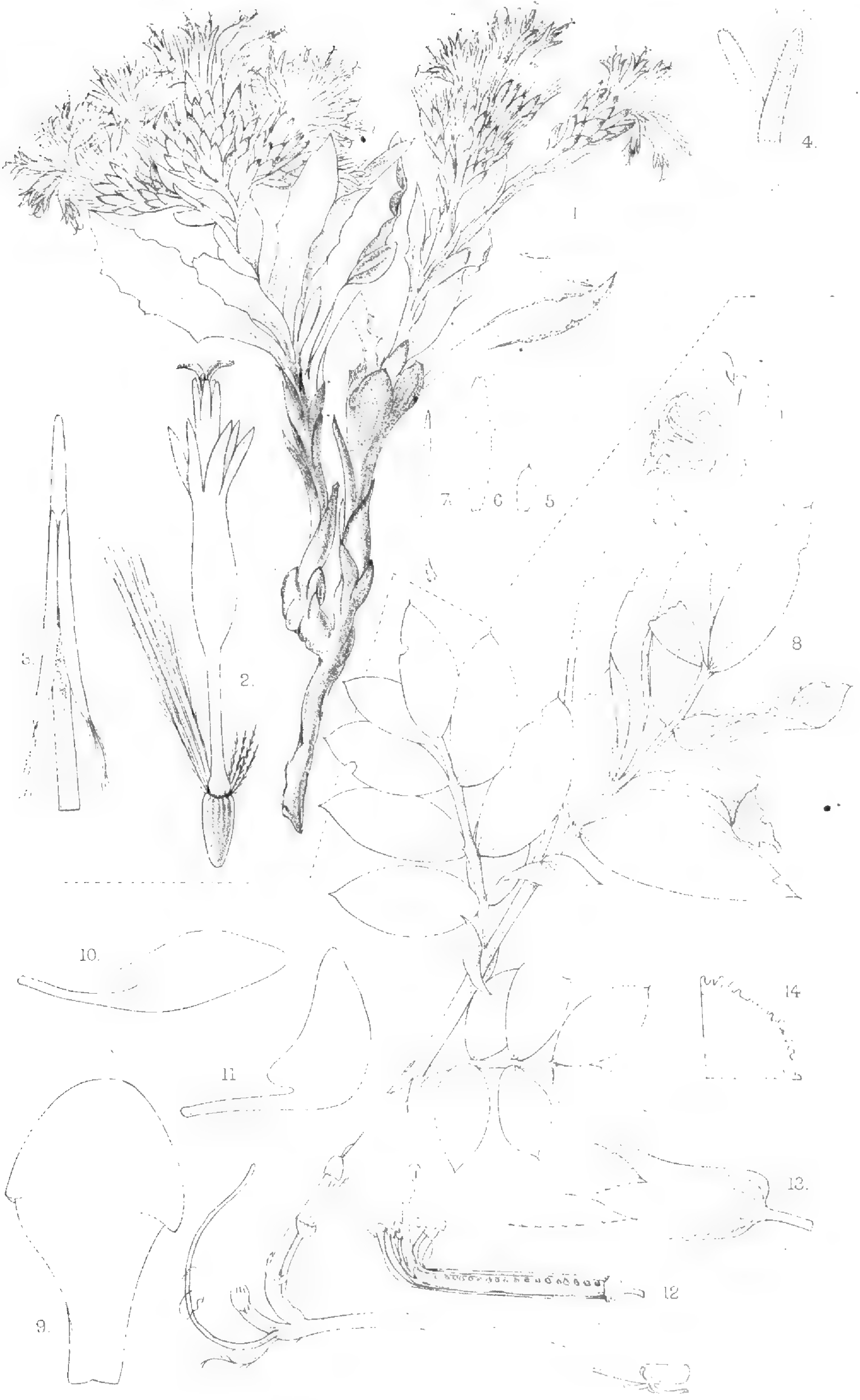
1. Plant (nat. size). 2. Fruit, × 5. 3. Transverse sections of mericarp, × 6.

Figs. 4–12. POA PRICEI, N. D. Simpson.

4. Plant (nat. size). 5. Spikelet, × 7. 6 and 7. Glumes. 8 Valve and palea, × 5. 9. Half a valve. 10. Palea. 11. Caryopsis. 12. Ovary with stigmas.

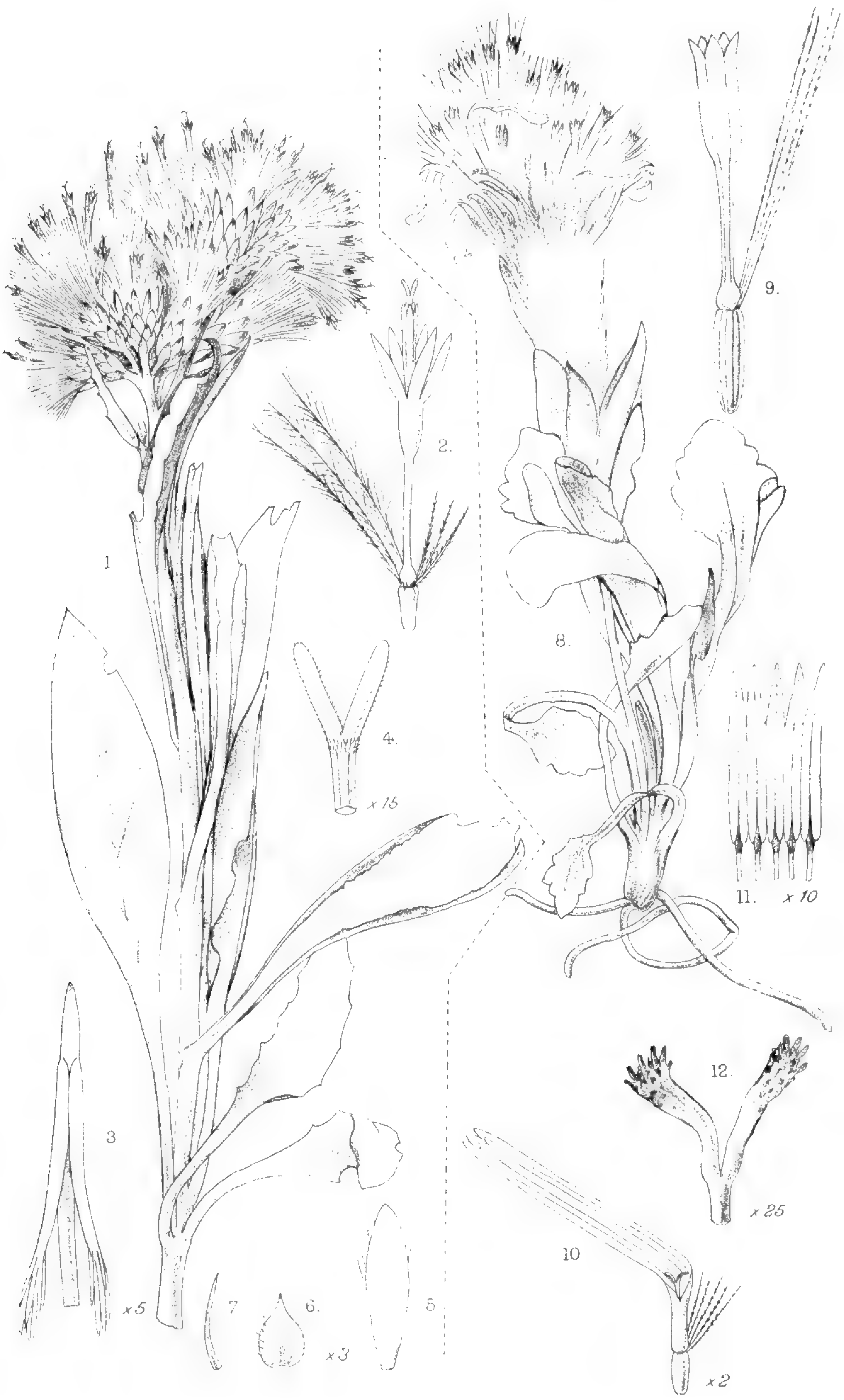


MAP OF NORTH-WEST MONGOLIA.



N. D. Simpson del.
J. N. Fitch lith.
West, Newman imp.

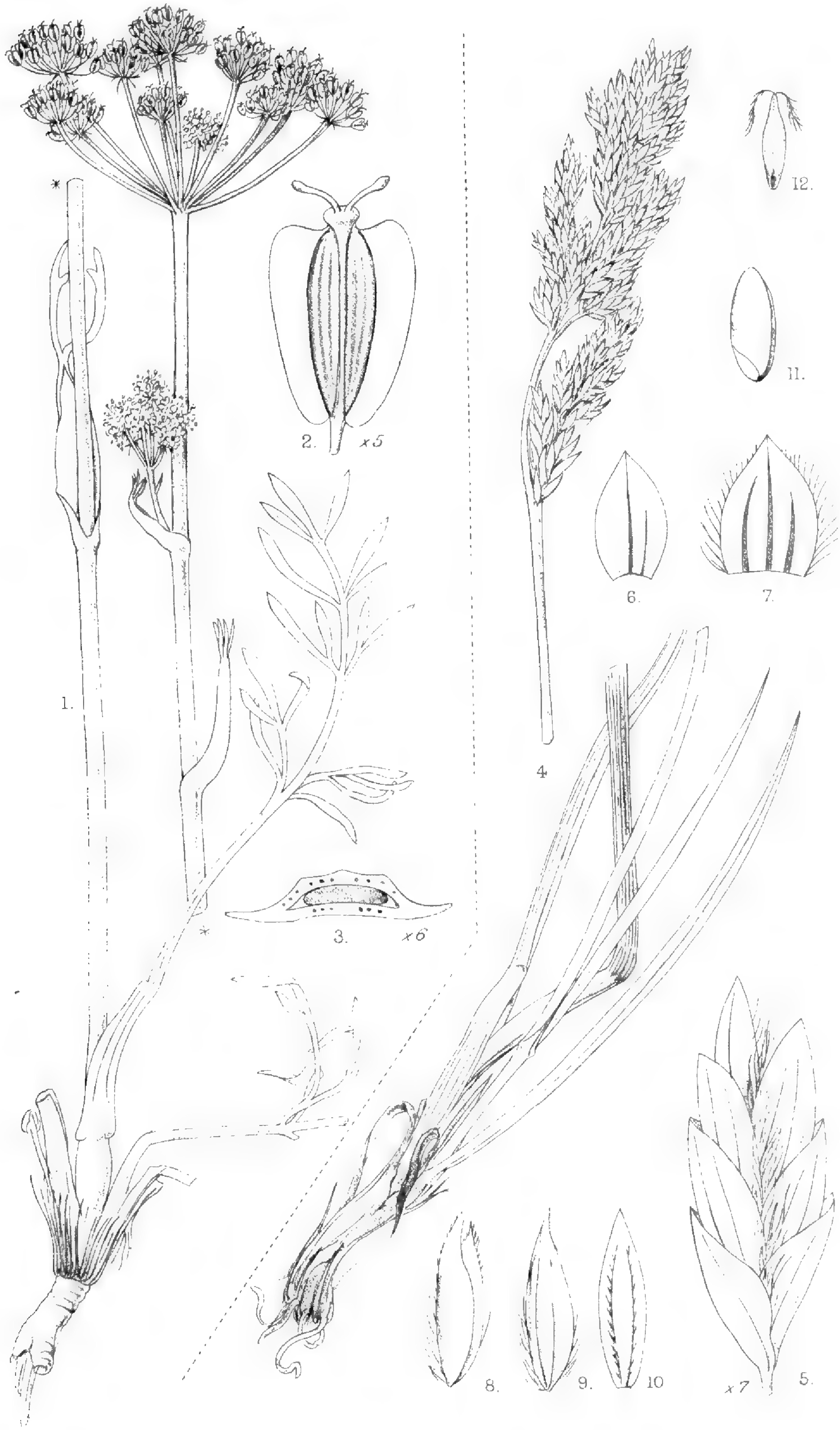
1-7, SAUSSUREA PRICEI, *N.D. Simpson*.
8-16, LATHYRUS FROLOWII, *N.D. Simpson*.



N D Simpson del.
J N Fitch lith.

West, Newman imp.

1-7, SAUSSUREA PSEUDO-ALPINA, *N.D. Simpson.*
8-12, SENECIO PRICEI, *N.D. Simpson.*



N.D. Simpson del.
J.N. Fitch lith.

West, Newman imp.

1-3, PEUCEDANUM PRICEI, *N.D. Simpson.*
4-12, POA PRICEI, *N.D. Simpson.*

The Structure of the Wood of East Indian Species of *Pinus*.

By PERCY GROOM, M.A., D.Sc., F.L.S., and W. RUSHTON, A.R.C.S., D.I.C.

(PLATES 24 & 25.)

[Read 1st May, 1911.]

IN India there are five native species of *Pinus*, whose names and distribution are :—

1. PINUS EXCELSA, *Wall.* A five-needled species with the vascular bundle single (haploxylic) in the leaf, a deciduous sheath of scales on the dwarf-shoot, and a terminal umbo on the cone-scale. It is definitely *temperate* and non-xerophilous in distribution, as it grows in the Western Himalayas at altitudes between 6,000 and 12,000 feet.

2. PINUS GERARDIANA, *Wall.* A three-needled species, haploxylic, with a deciduous leaf-sheath, and a central umbo on the cone-scale. It is definitely *xerophilous* in distribution, as it occurs in dry parts of the Western Himalayas, sometimes on dry, rocky slopes, and extends into Afghanistan ; its range of altitude is from 5,000 to 11,000 feet.

The remaining three species have diploxylic needles ; their leaf-sheaths are not deciduous ; their cone-scales have a central umbo each.

3. PINUS LONGIFOLIA, *Roxb.* This three-needled species lives largely in sub-tropical or even tropical climates, and is at least often xerophilous in habitat. In the drier Western Himalayas it ranges from 1,500 to 7,500 feet ; while in the moister Eastern Himalayas, for instance in Sikkim, it occupies dry southern slopes at altitudes between 1,000 and 3,000 feet. Webber describes the tree as sometimes growing on rocks in hot and dry woodlands.

4. PINUS KHASYA, *Royle.* This three-needled species is more Eastern in distribution and occurs in the Khasia and Naga Hills, also in Burma, at altitudes varying from 2,500 to 7,000 feet. According to J. D. Hooker it is not found in the wettest regions of the Khasia Hills where the annual rainfall may reach 600 inches. He describes the species as occurring in less wet places, for instance at an altitude of 6,000 feet on "moors" whose flora is distinctly temperate ('Himalayan Journals'). In Burma it occurs in dry hill-forests, according to Kurz. In the absence of adequate statistics as to soil and climate one surmises that this species can grow in habitats of considerable variety, in moist or moderately dry places in a temperate or subtropical, or perhaps even tropical climate.

5. Pinus Merkusii, *Jungh. & de Vriese.* This two-needled species is tropical in distribution. Occurring in Burma and the Malay Peninsula at altitudes varying from 300 to 3,500 feet, as well as in Sumatra and elsewhere. Apparently it can grow in dry or moist places, occurring, for instance, in very hot dry forests in the Shan Hills (according to H. N. Thompson).

A number of problems present themselves in regard to the structure of the wood of these species.

In the first place, what light is shed on their affinities? Or, as regards habitat, do the species growing under tropical or xerophilous conditions show any corresponding structural features in their wood? and are these correlated with the histological structure of the leaves? Incidentally we found ourselves faced with the problem as to the nature of "Sanio's bars" and markings on the radial walls of the wood-tracheids.

This paper is divided into two parts, the first of which gives the general conclusions and summary of results, the second part contains the special description of the different species.

GENERAL CONCLUSIONS.

The structure of the wood of all five species conforms with that of typical species of *Pinus* in the following features. There is a heart-wood. Annual rings are distinct, as the spring-tracheids have wider lumina and thinner walls than the more compressed summer- ("autumn"-) tracheids. The radial walls of the tracheids bear bordered pits, which are smaller and scantier in the summer-wood and have narrower orifices. There are longitudinal resin-ducts, the epithelium of which is thin-walled and develops thyloses. The medullary rays are of two kinds: *uniseriate*, which are one cell thick, and *pluriseriate*, which are several cells in thickness but taper towards the upper and lower margins, where they are one cell thick, so that in tangential section these rays are *fusiform*. These latter, so-called fusiform rays, include a resin-duct. Some of the medullary rays of all species have ray-tracheids, or parenchyma or both.

(*a*) Annual Ring.

The species *Pinus longifolia* shows double annual rings (Pl. **24**. fig. 18).

(*b*) Size of Tracheids.

The tracheids are shortest in the xerophilous *Pinus Gerardiana*, 3 mm., attain a length of 4 mm. in *P. excelsa* and *P. longifolia*, and 4·6 mm. in *P. Khasya*, and the relatively great length of 7 mm. in the tropical *P. Merkusii*. This last species also has by far the widest spring-tracheids, whose radial and tangential diameters are about 68·5 and 45 μ respectively and often exceed these dimensions. The species whose spring-tracheids come next in width are likewise pines growing often in subtropical or even tropical climates, namely *P. longifolia* (53·5 μ and 39·5 μ), and *P. Khasya* (52 μ and 25 μ), which grows in places among tropical plants in Burma. The temperate *P. excelsa* and the xerophilous *P. Gerardiana* have much narrower spring-tracheids, the respective diameters being 38·5 μ and 37·5 μ in the former, and 34 μ and 29 μ in the latter.

These distinctions suggested to one of us an enquiry into the effect of environment and systematic affinity on the width of spring-tracheids of species of *Pinus*. A separate paper * deals with this, but the main results are given here.

Pinus Gerardiana has the narrowest spring-tracheids either because it is xerophilous or because it belongs to the sub-section Para-Cembra, group "Parrya." The observed mean diameter of its spring-tracheids was 31·5 μ—those of the four haploxylic American species † with the narrowest spring-tracheids varied from 24 to 33 μ.

Pinus excelsa has broader spring-tracheids, either because it is not xerophilous or because it belongs to the section "Cembra" and group Strobus. The observed mean diameter of the spring-tracheids was 38 μ. Those of the American species belonging to the same group varied from 41·5 to 45 μ.

Pinus longifolia, *P. Khasya*, and *P. Merkusii* have widest tracheids because they are sub-tropical or tropical in distribution with sufficiency of moisture.

In the case of the rather xerophilous *P. longifolia,* as in those of American species of sub-tropical distribution in a moist climate, the periodically or permanent dry nature of the superficial soil is not associated with narrowness of spring-tracheids. The mean diameter of its spring-tracheids (46·5 μ) may be compared with those of two sub-tropical American species, *P. clausa* (48 μ) and *P. palustris* (49 μ), growing on dry sand in a moist climate. The sub-tropical and perhaps tropical *P. Khasya*, in which the observed mean diameter of the spring-tracheids was 43·5, practically agrees with the sub-tropical and tropical *P. cubensis* (44 μ) that grows in South Carolina and the West Indies.

Finally, the most tropical Asiatic species *P. Merkusii* has the widest spring-tracheids (56·5 μ), just as is the case with the most tropical American species *P. tropicalis* (50·8 μ).

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* Percy Groom, "An Enquiry into the Significance of Tracheid-width in Coniferæ," ined.

† In comparing the figures with those given by Penhallow for American species, it must be pointed out that we measured the widest of the spring-tracheids, but we do not know whether Penhallow followed the same procedure or took the mean diameter of all the spring-tracheids.

Thus from the diameters of the spring-tracheids in these last three forms we can form no conclusion as to the amount of water required by them in the substratum, though analogies with the American species indicate a considerable rainfall. On the other hand, they suggest a means of obtaining collateral evidence as to the climate under which fossil pines grew.

From the structure of the leaves of *P. longifolia* and *P. Merkusii* we should conclude that stomatic transpiration can be vigorous, as stomata are present on the outer (lower) face as well as the flanks.

(*c*) Shapes of Ordinary Tracheids.

The tracheids running longitudinally in the wood belong to two main types: (i.) ordinary long, more or less prosenchymatous tracheids; and (ii.) much shorter, "septate" or parenchymatous tracheids, whose terminal walls are transverse. The latter, which especially occur in the vicinity of the resin-ducts, will be described in connexion with these.

The majority of ordinary tracheids, whether they be the relatively thin-walled well-pitted spring-tracheids, or the thick-walled fibro-tracheids of the summer-wood, are straight and have more or less tapering, sharp or rounded ends. When abutting on a medullary ray the end may fork, or bend so as to run for some distance along the ray and thus form a transition towards a ray-tracheid, or may bend even through an angle of 180°, or finally may end squarely and abruptly against a ray-tracheid. These ends of the tracheids may bear pits in contact with the ray-tracheid, therefore on the terminal, or, in a sense, tangential walls.

But *Pinus Khasya* and *P. Merkusii*, also show bundles of tracheids which, though not connected with medullary rays, yet are bent towards their ends, the curvature being mainly in a radial plane, so that in extreme cases these are seen cut transversely in longitudinal, especially tangential, sections. On the bent parts of these tracheids bordered pits are abundant on the tangential walls and even on the blunt terminations. As these bundles frequently form a radial sheet only one tracheid in thickness, in transverse section they are denoted by a radial series of tracheids with tangential bordered pits in the spring-wood or summer-wood.

(*d*) Arrangements of Bordered Pits on the Radial Walls.

The bordered pits are oval or circular in surface view in the spring-wood, where they are ranged in one row, with occasional pairs, in *P. excelsa* and *P. Gerardiana*, in one or two rows in *P. longifolia* and *P. Khasya*, and in one, two, or three rows or in peculiar nests, of 3 or 4 in *P. Merkusii* (Pl. **25**. figs. 47, 48). The species that has triseriate pits is also the one that shows the greatest radial width of tracheid. But an examination of the statistics given by Penhallow (1907) shows that the number of longitudinal rows of bordered pits on the radial walls is not determined by radial width of lumen, as the haploxylic species are mainly uniseriate, and that paired or biseriate pits occur only in two haploxylic species with widest tracheids. But in the diploxylic species Penhallow's statistics show that the wide tracheids of *P. Taeda* and *P. palustris* have only uniseriate pits, whereas many with narrower tracheids have uniseriate or occasionally paired pits, or even 1–2-seriate pits. Systematic affinity undoubtedly is one of the determinant factors. In the Indian species the point worthy of note is that *P. excelsa* and *P. Gerardiana* show the uniseriate arrangement prevalent in the haploxylic species. As is well-known, in one and the same species width of tracheid may appear to determine the number of rows, because in the summer-wood (of all the Indian species also) the radial pits are uniseriate.

(*e*) Sanio's Rims.

The radial walls of the spring-tracheids of the secondary wood of *Pinus* show certain narrow, transverse, or more or less curved strips that appear lighter than the rest of the wall and generally stain less deeply than this when treated with certain solutions (phloroglucin and hydrochloric acid, or safranin) which stain lignified membranes. (Sometimes, when sections deeply stained with safranin are decolorized, differentiated by clove oil, and mounted in Canada balsam, these bands are on the other hand the parts that retain the stain most deeply.)

Now Sanio showed that in *Pinus sylvestris* the differentiation of bordered pits is preceded by the delimitation of certain oval or elliptical patches bounded above and below by curved bow-like lines. According to Sanio it is only within such oval patches that bordered pits arise; hence he termed each patch a "primordial pit" and we term it "the primary pit-area." In such an area Sanio showed that one bordered pit, or two side by side, may arise, but usually the primary pit-area in the spring-tracheids is not completely covered by the pit or pits; there remains behind a margin above and below. According to Sanio's work it is these unoccupied margins of the primary areas that coincide in position with the above-mentioned bands that are seen in radial section. Consequently the name "Sanio's rims" may be given to the structures causing the band-like appearance. According to Sanio sometimes a bordered pit does occupy the whole of the primary pit-area, and with this fact may perhaps be correlated the absence of any distinct Sanio's rims in a number of cases. When the primary pit-areas are in contact, the two contiguous Sanio's rims are naturally "fused" and form a band that is transverse and single, except possibly at the two lateral edges where the natural curvature of each original boundary of the area causes the band to fork. When, on the other hand, the primary pit areas are farther apart, they are separated by a stretch of wall that gives the full reactions of lignified membranes, and Sanio's rims are bands confined to the neighbourhood of the pits. In *Pinus excelsa* there is additional evidence that the structure at least of the inner layer of the radial wall centres round the pit-areas bounded by Sanio's rims: for when two uniseriate pits are at some distance apart the space intervening between them is occupied by the two narrow fringing curved bands (Sanio's rims), and between these by a stretch of wall showing striations which near the bands are curved in the same sense as these, but at increasing distances from the bands show decreasing curvature until midway between the two pits the striæ are straight and transverse. All the Indian species of *Pinus* show Sanio's rims. In *P. excelsa* and *P. Gerardiana* in the primary pit-area only one pit forms but occasionally two side by side may arise, whereas in the other three Indian species two pits are commonly produced side by side in one area. But *P. Merkusii* is unique among known living pines in that in one primary pit-area there may be produced either three pits side by side, or three forming a cluster, of which two are lateral and approximately side by side, while the third is median above or below, or finally four forming a cluster like the last except that there are two median, one above and one below (Pl. **25**, figs. 43, 47, 48). Other deviations regarding the arrangements are described in the detailed description of *P. Merkusii.* Sometimes Sanio's rims completely surround the pit-bearing area, that is, also on the sides; in such a case they literally become a single fringe or margin (figs. 43, 46, 47).

The detailed structural relations in regard to these Sanio's rims we investigated in connexion with *P. Merkusii.* In *radial* sections with iodine and sulphuric acid the "rims" stain yellow; with ordinary hæmatoxylin they remain unstained; leaving sections in cupra-ammonium to dissolve out any cellulose, their staining properties are not changed materially. They are not composed of cellulose. They stain more deeply than the rest of the wall with iron-hæmatoxylin, with methylene-blue followed by immersion in 2 per cent. acetic acid, also with ruthenium-red. Treating radial sections with ammonium oxalate, or successively with 2 per cent. hydrochloric acid for half an hour and then boiling for two hours in 2 per cent. caustic soda, they do not stain with ruthenium-red or with methylene-blue and acetic acid. Therefore "Sanio's rims" are at least partly pectic.

Now the fact that a single straight band may be seen in radial section continuing across two or more tracheids, proves that the phenomenon is associated in some manner with the middle lamella. In *tangential* sections the appearance of these bands is seen to be due to a circular, or fusiform band-like, localized thickening of the middle lamella: where two successive superposed pits are close together the thickening between them is single, but where the pits are some distance apart there are two such thickenings, one near each pit. The thickenings are seen to be separated from the actual pit by a short stretch of wall. These thickened parts of the middle lamella differ somewhat from the middle lamella elsewhere in chemical composition, for they do not stain crimson with phloroglucin and hydrochloric acid, whereas elsewhere the middle lamella is thinner and does stain more or less. Tangential sections stained in safranin and mounted in Canada balsam show these thickenings unstained and appearing like empty intercellular spaces, because their refractive index agrees with that of the balsam, whereas the rest of the middle lamella may be quite distinct. Stained with methylene-blue succeeded by 2 per cent. acetic acid or ruthenium-red (especially after being swollen by successive treatment with hydrochloric acid and ammonia) they stand out from the rest of the wall as more deeply stained parts of the middle lamella (fig. 38), though the other parts of this also frequently stain with ruthenium-red. In *transverse* section treated with ruthenium-red Sanio's rims are seen as deeply stained lines in the middle lamella of the radial walls, and contrast with the scarcely stained middle lamella in the tangential walls or in radial walls where the rims are lacking. (In our specimen a number of the tracheids in contact with medullary rays showed in transverse section the inner layers of the tangential walls, and sometimes of the radial walls, delignified and staining with ruthenium-red. Tangential sections showed that this is due to the occurrence of patches of pectic substance situated at the levels of the medullary rays. This localized pectic lining is due to the action of a fungus which is mainly distributed in the medullary rays into the adjoining tracheid, which run mainly in a tangential transverse direction.)

Combining the above given facts with Sanio's account of the development of pits in primary pit-areas, the following would therefore appear to be the truth. When young the actual marginal portion of the primary pit-area does not thicken by deposits of lignified wall so soon as it does elsewhere (except on the pit-closing membrane) but thickens by successive deposits of pectic substance until a stage is reached when lignified wall-substance is deposited even over the now thickened rims of the primary pit-area. Sanio's rims represent a system of rod-like or band-like pectic thickenings of the middle lamella running transversely in the radial walls and linked here and there by slightly curved longitudinal band-like similar thickenings (representing the lateral margins of the primary pit-areas).

In tracheids at the junction of the spring- and summer-wood, where the pits are uniseriate, Sanio's rims as seen in radial section are reduced to little crescent-shaped areas in a median position above and below each pit, and not as broad as the pit (fig. 44). In the summer-wood outside this critical layer Sanio's rims are not to be seen in radial section, even after staining with ruthenium-red. In tangential section the middle lamella here does not dilate close to the pit; it only broadens very slightly where it is forking just before passing into the wall of the pit-chamber; moreover, the staining of the middle lamella with ruthenium-red is the same throughout and is rather light.

It is worthy of note that in staining radial sections with ruthenium-red or with methylene-blue, the part of Sanio's rim that stains most readily and deeply is frequently the part immediately beneath the centre of the pit, and when the Sanio's rims are dwindling in the outer spring-wood or inner summer-wood it is lateral or marginal parts that vanish first while the central parts remain.

As there appears to be some confusion concerning the meaning of the term "Sanio's bars" some comments may be made. In radial longitudinal sections of coniferous woods the appearance of transverse bands running across the tracheids is caused by three entirely different sets of structures:—

(i.) There are bars or rods stretching across the lumen from tracheid to tracheid and forming a continuous radial series, extending through a few tracheids or through one or more annual rings. Similar bars often extend across the lumina of sieve-tubes. In the wood these are lignified, but in the phloem they react as cellulose. C. Müller (1890) was the author of the name "Sanio's bars" and, as he explicitly stated, he coined the term to designate these structures as first discovered by Sanio in *Pinus sylvestris* (1873–4). In a radial section the individual rods are seen to form a continuous line and only one such series is seen, as a rule, in a single longitudinal radial section; these rods then are limited in number.

C. Müller (1890), on the basis of his observations, formulated the proposition that Sanio's bars occur in all the sub-groups of the Coniferæ (including *Araucaria* and *Ginkgo*) and that they arise as folds of the radial walls. The proposition as to Sanio's bars has been incorrectly restated by Miss Gerry *.

(ii.) There are structures known as "resin-plates" arranged somewhat in the same manner as seen in radial section. They are found most frequently or exclusively in contact with medullary rays. In radial section they are generally deeper than Sanio's bars, usually clearly dilated against the tracheid wall, and often form a complete partition dividing the lumen of the tracheid into two chambers.

(iii.) There are certain markings which form a pattern on the radial walls of the tracheids, especially in the spring-wood. The markings are largely in the form of transverse bands, but contrast with the other bands seen in radial section in that in every spring-tracheid numerous bands are visible, and in that they do not usually continue in the same straight line through a number of tracheids. These bands are the structures that we term "Sanio's rims."

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* Gerry, in Ann. Bot. xxiv. (1910) pp. 119–123.

Not in any one among these three kinds of markings in the wood is the bar, plate or band composed of cellulose.

Miss Gerry, working with Professor Jeffrey, in her paper on the "bars of Sanio," was obviously not dealing with "Sanio's bars" but with the structures that we term Sanio's rims. She describes them as "bars" or "folds" of cellulose and specifically mentions their presence in *Pinus*. In this genus we have shown that these bands are not ridges, bars, or folds projecting into the lumen, but occur at regions of the wall where this is no thicker than elsewhere, and that each consists of a locally thickened pectic middle lamella overlaid by lignified layers. The evidence of the cellulose nature of these bands provided by Miss Gerry is quite inadequate, since the sole fact given by her in support of her statement is that the bands stain with hæmatoxylin. We entirely failed to make these structures stain with this dye excepting in the form of iron-hæmatoxylin, which of course may be readily deposited as a stain in pectic bodies and particularly in the middle lamella of wood. Hence it remains to be seen if these bands are composed of cellulose in any of the Coniferæ.

(*f*) Structure of the Bordered Pits on the Radial Walls.

In the spring-wood the bordered pits on the radial walls are larger and generally have broader orifices. In the summer-wood the orifices are more or less fusiform and more approximating to the vertical oblique, and may be continued out with long oblique furrows arranged in a steep spiral.

(*g*) Bordered Pits on the Tangential Walls.

Only two Indian species, *P. excelsa* and *P. Gerardianá*, regularly show pits on the tangential walls of all the outer summer-tracheids.

Tangential pits are known to occur sporadically in narrow annual rings of various Abietineæ (see Strasburger). They occur in *P. longifolia*, *P. Khasya*, and *P. Merkusii*, in spring-wood or summer-wood, but in the last two species they are abundant especially in the spring-wood in the radially deflected bundles of tracheids already described, though the annual ring was broad in our specimen of *P. Khasya*. Small bordered pits occur on the tangential walls on the radially outer and inner sides of the tracheids around the resin-ducts, at least in some Indian species of *Pinus*, e. g., *P. Gerardiana* and *P. excelsa*.

(*h*) Other Structural Features of the Tracheids.

As regards the thickness of tracheid-wall and size of lumen the transition form spring-wood to autumn-wood is, as would be anticipated, gradual in the haploxylic *P. excelsa* and *P. Gerardiana*, and more sudden in the diploxylic *P. longifolia* and *P. Merkusii*, but unexpectedly is gradual in the diploxylic *P. Khasya*. As seen in radial section the walls of the tracheids are very clearly thicker, against the medullary rays than elsewhere.

Radial lignified bars, "Sanio's bars," stretching across the lumina of a series of tracheids were seen in several of the species. The bars seen in transverse section were hollow, and mostly cylindrical, but close to the attachment to the tracheid-wall the bar may deepen so that the contours of it and its cavity are vertically elongated (Pl. **24.** fig. 22).

"Resin-plates" occur in some of the Indian pines, e. g., *P. excelsa.*

(*i*) Resin-Ducts

In all the Indian pines except *P. Gerardiana* the resin-ducts are most abundant in the outer part of the annual ring, but in that species they are most numerous in the middle part of the ring and are unusually uneven in distribution, being locally scanty.

P. longifolia and *P. Khasya* are marked by great development of the ducts ; in the former the ducts are very wide (diameter ·2 mm.), and solitary or in pairs, mostly in the outer and middle parts of the annual ring. *P. Khasya* has very numerous ducts ranged usually in groups of 2–4.

The species show the following types of cells associated with the ducts (figs. 2, 20, 31, 42).

(i.) Thin-walled epithelium lining the duct.

(ii.) Thin-walled, more elongated parenchyma.

(iii.) Thick-walled, still more elongated parenchyma, the walls of which bear numerous simple pits.

(iv.) Parenchyma-tracheids, much shorter than ordinary tracheids, with bordered pits on all their walls, including the terminal transverse walls.

(*k*) Medullary Rays.

Except in *P. excelsa* thin-walled parenchyma, as well as thick-walled, occurs in the medullary rays. This species has only the latter.

In all Indian pines ray-tracheids, both marginal and internal (so-called "interspersed"), occur. In the haploxylic species *P. excelsa* and *P. Gerardiana* the ray-tracheids bear no denticulations on their walls, or in the latter species such denticulations are scantily and feebly suggested. The three diploxylic species all have denticulate ray-tracheids.

The marginal ray-tracheids assume various forms including shapes transitional towards bent ordinary wood-tracheids (figs. 11, 12, 34, 41). Similar peculiar forms have been described by W. P. Thompson (1910). In *P. excelsa* long marginal ray-tracheids with a narrow tapering lumen (fig. 11) were seen in connexion with ray-tracheids that approximated in form to those characteristic of "*distended medullary rays.*" There occur uniseriate rays of this latter type entirely composed of peculiar lobed, vertically dilated ray-tracheids, whose connexion with one another is slight or possibly even lacking (fig. 10).

Where the medullary rays cross a resin-duct the ray-tracheids, or thick-walled parenchyma, do not (as is usually stated in regard to *Pinus*) necessarily give way to thin-walled parenchyma, though such a change sometimes does take place. Possibly the determinant factor is the distance of the medullary ray from the actual resin-duct, and the nature of the cell that it crosses; if crossing a parenchyma-tracheid for instance the ray-tracheid would probably persist across the duct.

Details concerning the shape and size of the pits of the various kinds of ray-cells are given in the special descriptions of the different species.

(*l*) Conclusions as to the Systematic Affinities and Œcological Structure.

Pinus excelsa and *P. Gerardiana*.

P. excelsa and *P. Gerardiana* agree in the following features: the leaf is haploxylic, the scaly sheath of the dwarf-shoot is deciduous, the transition from the spring-wood to summer-wood is gradual, the outermost tracheids in the summer-wood have tangential pits and the ray-tracheids have feeble or no denticulations. For these reasons both belong to one and the same great subdivision of *Pinus*. But in *P. excelsa* the needles are in tufts of five, the cone-scale has a terminal umbo and the ray-parenchyma has large apparently simple pits in the lateral walls. This species therefore belongs to the subsection Cembra (Parlatore), and since its cone-scales are thin and the cones long it belongs to the group Strobus. But, according to Penhallow, in the species constituting the subsection Cembra the upper walls of the ray-parenchyma cells are thin: if this be correct, *Pinus excelsa* stands apart from all these. As regards width of spring-tracheids the American species belonging to the Section Haploxylon that most closely approach it likewise belong to the group Strobus.

Pinus Gerardiana differs from *P. excelsa* in that its cone-scale has a central umbo and is thick, its leaves are in tufts of 3, and hence it is separated, for instance by Koehne, from Cembra as a member of the sub-section Para-Cembra. H. Mayr (1890) noted that the small clearly half-bordered pits on the lateral walls of the ray-parenchyma ally it with the other species constituting this sub-section. It agrees with typical members of the Haploxylon Section in its uniseriate pits on the radial walls of the wood-tracheids.

In altitudinal range there is not much difference between *P. excelsa* (6,000–12,000 ft.) and *P. Gerardiana* (5,000–10,000 ft.), but the latter alone is xerophilous in habitat: and its leaf has a much thicker cuticle and the hypoderma has thicker walls. The greater development of transfusion-tissue in *P. Gerardiana* perhaps might be associated with the greater thickness of the leaf, but Max Scheit (1883) concluded that the amount of transfusion-tissue varies directly with the external influences promoting transpiration, and the great development of the resin-ducts in this species recalls the extensive production of ethereal oil glands in the leaves of plants in dry hot places.

Pinus longifolia, *P. Khasya*, and *P. Merkusii.*

These three species agree not only in the diploxylic nature of the leaves, the persistent nature of the sheath of the dwarf-shoot, and the possession of a central umbo on the thick cone-scale, but also in that the transition from spring-wood to summer-wood is sudden (except in *P. Khasya*), the outermost tracheids of the annual ring do not universally bear pits on the tangential walls, the pits on the radial walls of the spring-tracheids are often 2-seriate, and the ray-tracheids are denticulate.

As already pointed out, these three species that frequently grow under subtropical or even tropical conditions are, like the sub-tropical American pines, the species possessing the widest spring-tracheids, despite of the fact that *P. longifolia*, and apparently sometimes the other species, live in situations that are at least temporarily dry. As regards leaf-structure all three have stomata on all their faces. *P. longifolia*, the most clearly tending to xerophily, has the thickest cuticle (though not so thick as *P. Gerardiana*), and *P. Khasya* has the thinnest. *P. Merkusii* has the most numerous lines of stomata, as its twelve lines of stomata imply that these are about ·2 mm. apart on the average; whereas in *P. Khasya* and *P. longifolia*, with 10 and 8 stomatic lines respectively, these are on the average ·26 mm. apart. In the more xerophilous *P. longifolia* the endodermis has markedly thickened outer walls, in *P. Merkusii* this is less marked, while in *P. Khasya* there is no indication of such thickening. All three species contrast with the haploxylic Indian species in the feebler development of the tissue separating the endodermis from the vascular tissue. The sub-endodermal layer forms a fenestrated cylinder of transfusion-tissue, in addition to this there is usually only one layer of complementary tissue, excepting in *P. longifolia* where there is a disproportionate development of mechanical tissues 1–3 cells thick. The xylem is well developed in all three species. The two three-needled species have merely two marginal resin-ducts, whereas *P. Merkusii* also has a median one against the outer face: in all three cases the ducts are against the hypoderma. All these facts collectively seem to indicate that these three species of *Pinus* live in a region of considerable annual rainfall, but can endure a considerable season of drought.

As regards features of systematic significance, *P. Merkusii* is perhaps the most interesting abietineous plant in existence from the point of view of structure of wood, which shows possible relations to the araucarian type of pitting on the radial walls. So far it is the only existing conifer known to have these pits arranged in the cluster-like manner already described. In certain Cordaites (*C. Newberryi*) the pits are arranged in clusters which in the successive tracheids of a radial row form a radial series, so as to present the appearance of the possibility that the grouped pits correspond to the position of contiguous medullary rays. The pits forming one group or cluster are more numerous than in *Pinus Merkusii.* Gothan (1910) describes and figures a fossil conifer, *Cedroxylon transiens* (Gothan), whose wood shows in some of the tracheids typical araucarian pitting, and in other tracheids little clusters of 3–4 pits, very similar to those of *P. Merkusii.* He regards this clustered arrangement as the first step in the change from an araucarian type of pitting towards the abietinean condition. If this "star-like" (as Gothan terms it) arrangement is thus a transitional stage between the two conditions, *P. Merkusii* completes the picture by providing a type that has the typical abietinean pitting and the clustered "star-like" arrangement, so that the stages between the two extremes are now known. *P. Merkusii* also shows appearances that may be interpreted as transition between the alternate (araucarian) and opposite (abietinean) arrangement of these pits (fig. 46). So far as we are aware no other living conifer, outside the Araucariaceæ, has triseriate pits in the radial walls of the spring-tracheids: the pits are not arranged alternately as in the araucarian type, but are opposite.

SPECIAL DESCRIPTION OF THE SPECIES.

PINUS GERARDIANA (*Wall.*).

Pinus Gerardiana, the Himalayan edible pine, a species with its leaves in 3-needled tufts, is clearly xerophilous in distribution, as it occurs in the "inner dry and arid West Himalaya" (Gamble, 1902), at altitudes varying from 5,000–10,000 ft., also in Afghanistan, Kafiristan, and in the Hariab district (7,000–11,000 ft.), moreover the species is social on "dry steep rocky slopes" (Gamble). The thick leaf is xerophytic in structure, for the epidermis has very thick walls, including thick cuticle and cuticular layers; the stomata are sunk, and there is a thick-walled hypoderma. Despite this xerophilous distribution and xerophytic structure the bark is "very thin, grey, smooth, and cracked only in very old trees" (Gamble). Europe, however, supplies an analogue in *Betula alba*, whose habitat is often dry.

A. Macroscopic Features (naked eye).

The heart-wood is light brown. The annual rings were 17 to the inch in our specimen, 13 in Stewart's specimen (Gamble). The transition from the spring-wood to summer-wood in the same annual ring is gradual. The relative proportions of the spring-wood and summer-wood varied widely in different annual rings: the latter forming from $\frac{1}{8}$ to more than $\frac{1}{2}$ of the ring. The medullary rays are invisible in transverse section but show as thin darker bands on the radial section. The resin-ducts, just visible in transverse section, are noticeable on the longitudinal section as dark lines; their distribution in the annual ring is uneven, as they are scattered and often locally scanty, though generally more numerous in the later spring-wood and early summer-wood, they are not lacking from the inner and outer boundaries.

B. Microscopic Structure.

Tracheids.

In transverse section the spring-tracheids are square or oblong-rectangular, with the slightly longer axis radial or tangential. The gradual decrease in radial diameter and in thickness of wall in the summer-wood culminates in the outermost tracheids, which are very compressed thick-walled fibro-tracheids.

The following are measurements of typical tracheids:—

	Width of Lumen.		Thickness of Wall.	
	Radial.	Tangential.	Radial.	Tangential.
Inner spring-tracheid	34 μ	29 μ	3·5 μ	3·5 μ
Outermost summer-tracheid..	8 μ	21 μ	6 μ	8 μ

Length of tracheid 3 mm.

The tracheids show three sets of deviations from normal shape as regards their ends:—

1. Where they terminate against a medullary ray the straight end may be rectangular-truncate or forked, but the end may bend radially inward. Bordered pits occur on the bent part or truncate end.
2. Here and there the tracheids bend radially inwards at their ends and dovetail, and on the dove-tailing terminal portions there are pits on the tangential walls in the spring-wood.
3. In the vicinity of resin-ducts rectangular parenchyma-tracheids occur.

The bordered pits on the radial walls are uniseriate though occasionally they occur in pairs. In contour the pit-chamber is oval or circular (fig. 6), the former especially often in the spring-wood, whilst the aperture in the inmost spring-wood is circular or slightly oval with the longer axis transverse; but travelling outwards in the ring the aperture becomes gradually oblique or even vertical (Pl. 24. fig. 8), broadly lenticular, not becoming narrow lenticular except perhaps in the outermost layer. Moreover, the pointed ends of the aperture are continuous with oblique line-like furrows which may be continuous with like ones from higher and lower pits, so that the spiral arrangement of the pit-apertures is very evident. (It is possible that these line-like furrows are not natural to the wood in the tree, but are due to desiccation and consequent fracture.) The longitudinal distance apart of the pits in the spring-wood is very variable in tracheids. Sanio's rims are distinct.

The outer summer-tracheids also possess on their tangential walls smaller, more irregularly arranged, bordered pits, which are scanty and uniseriate in some tracheids, and more numerous and up to triseriate in others. They are most numerous in the outermost two or three layers, but occur in the latest five series of tracheids. In any case they occupy a relatively small area of the wall, and agree in structure and approximately in size with the pits on the radial walls of the summer-tracheids: the outline of the chamber is circular and that of the orifice is lenticular (fig. 7).

Resin-Ducts.

The ducts attain a diameter of 120 μ and their epithelial cells a radial width of 14 μ. The flattened epithelial cells give rise to numerous occluding thyloses. Around these are two layers of rather flattened parenchyma with somewhat thicker pitted walls, which are longer and have their thinnest walls towards the resin-epithelium. These are succeeded on the outside by parenchymatous cells which are oblong rectangular in longitudinal section and have thicker walls; and these in turn by parenchyma-tracheids of similar shape with relatively thin walls and few bordered pits which occur on the end walls as well as on the lateral, including tangential walls in summer-wood and spring-wood (fig. 2). The lengths of measured parenchyma-tracheids were ·114, ·25, ·27, and ·5 mm., in comparison with 3 mm. the approximate length of the ordinary tracheids. Thus around the resin-ducts there are cells showing transitional stages from epithelial parenchyma to typical tracheids.

Medullary Rays.

The linear usually uniseriate rays vary in height from 1 to 24 cells. The fusiform rays attain a height equivalent to 30 cells, but some of them are shallower than the tallest uniseriate rays.

In addition to ray-tracheids, there are two kinds of parenchyma-cells, thick-walled and thin-walled.

Each *thick-walled parenchyma-cell* is radially elongated and in length equal to the radial diameters of 4–6 tracheids in the spring-wood and about 8 tracheids in the summer-wood. In tangential view the lumen is an upright oval, and the general contour is vertically oblong with rounded angles in uniseriate rays, but the contour is more rounded near the central parts of the fusiform rays. Their end walls are oblique or transverse. On the lateral walls the pits are very small, half-bordered (Picea-like) and circular in contour, but their orifices opening into the tracheids are lenticular and oblique. These pits are not nearly so tall as the height of the ray-cell, on the walls of which they are ranged in one or two tiers, and there are 2–3, usually two pits in each tier to the radial width of each tracheid, but only 1–2 in the summer-wood—therefore, as a whole, 2–5 in the spring-wood (fig. 4). In the summer-wood the apertures are much elongated and oblique (fig. 3). The upper and lower walls, as well as the end walls, the latter especially near the margins, have rounded pits.

The *thin-walled parenchyma-cells* are enlarged radially with straight transverse or oblique, or bow-like terminal walls, which are devoid of special thickenings or pits.

The *ray-tracheids* have transverse or oblique ends, bordered pits on all their walls, and are devoid of denticulations or very feebly and scantily denticulate in the case of the marginal ray-tracheids.

The *uniseriate rays* (fig. 5) are nearly entirely composed of thick-walled parenchyma and ray-tracheids, mainly the former. The latter are very largely marginal, but some internal ray-tracheids occur in smaller or larger numbers. Where the ray passes a resin-duct and comes in contact with the parenchyma surrounding this, thin-walled parenchyma partially replaces the thick-walled, but there are also a few thick-walled parenchyma-cells which are continuous with similar ones or with ray-tracheids. This change is quite local and the ray assumes the original structure after passing the duct.

Occasionally *biseriate rays* devoid of resin-ducts may be seen.

The *fusiform rays* (fig. 1) in tangential section are often slender, sometimes being one cell in thickness except in the central part where the resin-duct is. In tangential section the resin-duct is bounded by a wall of about four thin-walled flattened epithelial cells (which grow inwards to form thyloses). These are ensheathed by a single layer of similar cells, which on the flanks are in contact with the wood-tracheids. These in turn are succeeded by a little collection of thin-walled wider parenchymatous ray-cells, usually in two tiers, but among them may be an isolated, thick-walled parenchyma-ray cell. The thinner portions of the ray, which are biseriate towards the centre and uniseriate towards the margins, are mainly composed of thick-walled parenchyma, with one or two tiers of marginal ray-tracheids.

Hence apart from or surrounding the resin-ducts, both types of rays are composed of thick-walled parenchyma, with a smaller number of marginal ray-tracheids, together with sporadic thin-walled parenchyma and internal ray-tracheids.

PINUS EXCELSA, *Wall.*

This five-needled species belongs distinctly to the temperate climate, as its range of altitude in the Himalayas is from 6,000 to 12,000 ft. Its area stretches from Afghanistan to Bhutan.

As this species is widely grown in Europe the appearance of the wood is familiar, but for the sake of completeness a brief description of the structure of this is given.

A. MACROSCOPIC FEATURES (naked eye).

The wood is light in colour, the sapwood being whitish and the heartwood a light red. In each annual ring the spring-wood gradually merges into the summer-wood with no sudden transition. The annual rings vary in width from $\frac{1}{4}$ to about $\frac{1}{30}$, or less, of an inch (in our Indian specimen the mean thickness was $\frac{1}{27}$ of an inch). The medullary rays are visible to the naked eye as yellow lines in the heart-wood. Resin-ducts are numerous in the outermost spring-wood and especially in the summer-wood.

B. MICROSCOPIC STRUCTURE.

Tracheids.

Spring-wood formed the greater part of the annual rings in our specimen: for instance, in one ring the radial row of tracheids was constituted of 28–30 forming the spring-wood, and 5–8 forming the summer-wood. In transverse section the inner spring-tracheids are mostly square or rectangular-oblong with a longer radial diameter. The transition to summer-tracheids is very gradual, and only a few of the outermost of these show marked shortening of the radial diameter. Below are given measurements of typical tracheids, whose length is 3·4–4 mm.

	Width of Lumen.		Thickness of Wall.	
	Radial.	Tangential.	Radial.	Tangential.
Spring-tracheids ..	38·5 μ	37·5 μ	3·4 μ	3·4 μ
Summer-tracheids..	11·5 μ	28·5 μ	4·4 μ	4·4 μ

According to Gamble's statistics the wood of *Pinus excelsa* is lighter in weight and less hard than that of *Pinus Gerardiana*: this is due to the thinner walls of both spring- and summer-tracheids, and perhaps to the smaller percentage of summer-wood in the former.

The tracheids have pointed ends except where they end abruptly on medullary rays. In the spring-wood the numerous pits on the radial walls are nearly entirely uniseriate, but occasionally paired. They are oval and transversely elongated or circular, with a transverse oval or nearly circular orifice. The torus is ragged at the edges and the membrane radially striated. Large simple pit-like structures occur between some of the bordered pits (fig. 16). In the summer-wood the pits on the radial walls are uniseriate, less numerous, and circular in outline, with steeply oblique and even nearly vertical orifices (fig. 15). Sanio's rims are narrow but quite distinct in the spring-wood.

In the outer summer-wood on the tangential walls there are present numerous small scattered bordered pits. These are most abundant in the outermost layer of the tracheids, but may be seen in the outer three layers. They are circular in outline, with nearly vertical-elongated fusiform apertures (fig. 14).

Radial bars, "Sanio's bars," occur scantily: each is usually a cylindrical rod with a minute canal in its centre.

Tracheids with the so-called "resin-plates" occur against some of the medullary rays.

Resin-Ducts.

Each resin-duct has a flattened layer of thin-walled epithelial cells, which are broadly brick-shaped in longitudinal tangential view. In our specimen all the resin-ducts were blocked by numerous large thyloses. Around the epithelium are parenchymatous cells whose form varies with the distance from the epithelium. The cells adjoining this are elongated brick-shaped with thin walls, and large rounded simple pits. Outside these the cells are longer, narrower, and still square-ended; their walls are thicker and lignified, and the simple pits are smaller; against the tracheids the pits are half-bordered. Finally there are parenchyma-tracheids whose terminal walls are transverse or somewhat oblique; these have small bordered pits on all their walls. The parenchyma extends farther in a tangential direction towards a medullary ray than towards the reverse side; moreover, this production of wood-parenchyma in contact with the medullary ray may be continued on the side of the latter that is distant from the duct.

Medullary Rays.

The uniseriate rays are distinctly shallower than the fusiform rays, as they vary from 1–12 cells in height, whereas the latter rays are often equivalent to 18 or 19 cells in height.

Apart from the resin-producing epithelium the parenchyma shows two extreme forms, and ray-tracheids occur. Some of the uniseriate rays are composed solely of ray-tracheids.

In particular some rays, so-called "*distended rays,*" consist solely of a line of ray-tracheids of characteristic shape. In such rays each tracheid on the radially inner end is blunt or tapers to a more or less fine point, it widens in an outward direction and divides at its widest region into two or three marked lobes arranged in a vertical plane. In the case of two-lobed tracheids, the ends of the next tracheid dovetails with the two lobes; in the case of the three-lobed tracheids, the medium lobe may be continuous with the beginning of the next ray-tracheid, or the successive ray-tracheids are not in contact (fig. 10). More or less similar ray-tracheids occur marginally on other uniseriate rays that include parenchyma (fig. 11).

In normal rays the *ray-tracheids* are mainly marginal though internal ray-tracheids do occur, and their radial continuity is sometimes disturbed by the intercalation of ray-parenchyma. Sometimes there occur very long slender ray-tracheids whose lumen locally is reduced to a thin line (fig. 12). The ray-tracheids show bordered pits on all their walls, and are devoid of denticulations.

The *ray-parenchyma* is composed of rather thick-walled cells elongated radially and having simple pits on all their walls. On the radial walls the typical broader ones have large oval pits elongated radially; in the spring-wood to the radial width of one wood-tracheid there is one pit, which nearly stretches across the whole height of the cell, or occasionally two or three pits: when there are three the pits are in two tiers (fig. 9). In the summer-wood there is still one pit to the radial width of each tracheid, but the pit area is fusiform and steeply oblique towards the lumen and slit-like towards a tracheid. The end wall bears a few large pits, so that it belongs to Penhallow's "locally thickened type." The other parenchyma-cells are usually shallower, their pits are smaller and more crowded together so that the thick portions of the wall form bars which are linked to form a reticulum. These latter cells appear to be specially numerous close to the resin-ducts of the wood of the medullary ray. The parenchyma-cells often bulge into the lumen of the contiguous tracheid to form thyloses (fig. 17) (in sections the pit-closing membranes often also dip into the cavity of the parenchyma-cell itself).

In the *fusiform rays* the resin-duct is walled by a flattened epithelium (whose cells in our specimen had produced many thyloses). Surrounding this are thin-walled parenchymatous cells elongated radially (in our specimen on the flanks of the ray these were very much flattened as if crushed). Above and below in tangential section occur two or three tiers of triseriate or biseriate thick-walled parenchyma-cells, which in turn are succeeded by

4–6 similar cells forming a uniseriate series; sometimes the marginal cells, or rarely some internal cells, are ray-tracheids. The ray-tracheids are not abundant (fig. 13).

The *uniseriate rays* are mainly composed of ray-parenchyma, whose cells in tangential section are vertically elongated, with an oval lumen and an oblong-oval contour; these outlines are disturbed by the bulging in or out of the large pit-closing membrane. In some of these rays ray-tracheids are numerous (fig. 17). The length of the ray-parenchyma cell is equal to the radial width of 4–6 wood-tracheids in the radial spring-wood, and 2–4 in the summer-wood.

PINUS LONGIFOLIA, *Roxb.*

Pinus longifolia, the chir or long-leaved pine, is a three-needled species whose geographical distribution is interesting. According to Gamble (1902) and Brandis (1907) the tree flourishes in sub-Himalayan tracts and outer Himalayas. In the drier western region extending from Afghanistan to Nepal, it forms extensive pure forests at altitudes ranging from 1,500 to 6,500 and occasionally 7,590 feet, but does not grow in the inner valleys. In the *moister* eastern region it is less common, is often mixed with *Shorea robusta*, and in Sikkim is usually on dry southern slopes at altitudes between 1,000 and 3,000 feet. Thus this pine shows greatest success in regions that are least moderately dry, and Gamble points out that transplants will not endure a wet soil. In the drier western region its thick rough bark suggests the xerophyte and the light-demanding plant, in the moister eastern regions its bark is thinner. The suggestion has been made that its limited distribution in the eastern region is due to the rainfall being too heavy. The deep tap-root confers an ability to obtain moisture in dry places, and its capacity in this direction is doubtless enhanced by its power of flourishing as a sub-deciduous tree; for Gamble described the chir pine as more or less deciduous, while according to Brandis its needles remain on the trees for two or three years. In addition to its moderately xerophilous tendency this pine is exceptional in that it naturally occurs within the limits of the tropical climate, and "will thrive in the Indian plains, even at Calcutta" (Gamble, *loc. cit.*). Thus some interest also attaches to the structure of the leaves and wood.

A. MACROSCOPIC FEATURES (naked eye).

The light coloured sap-wood contrasts with the red- or pink-brown heart-wood. Annual rings and resin-ducts are very distinct to the naked eye. The number of rings to the inch radius varies according to Gamble from 2 up to 20; in our specimen there were 9. In each annual ring the summer-wood is rather abruptly marked off from the spring-wood. There is considerable variation in the proportions of the spring- and summer-wood forming one annual ring; in our specimen the summer-wood formed a fraction of the annual ring varying from one-half to one-eighth. The medullary rays are visible in transverse section, especially in the summer-wood and darker heart-wood, as light-coloured lines, and in radial section as slightly darker narrow bands. The resin-ducts are clearly visible and especially striking in longitudinal views as brown lines. They occur in the spring-wood and summer-wood, but appear to be more numerous in the middle and outer parts of the annual ring than in the inner. Their number appears to be independent of the relative amount of spring- and summer-wood.

B. Microscopic Structure.

Tracheids.

The transverse section of the tracheids in the earliest spring-wood tends to be oblong rectangular with the long axis radial; further out this changes to square, and ultimately in the summer-wood to rectangular with the long axis tangential. The change in size of lumen and thickness of wall is shown in the following table.

	Width of Lumen.		Mean thickness of Walls.	
	Radial.	Tangential.	Radial.	Tangential.
Early spring-tracheid . .	53·5 μ	39·5 μ	3·4 μ	3·4 μ
Late summer-tracheids .	10·5 μ	22·5 μ	8 μ	9·6 μ

Typical length of tracheid 4 mm.

Thus the outermost summer tracheids vie with fibres in thickness of wall and smallness of lumen.

Our specimen regularly showed "double annual rings." The spring-tracheids somewhere near the middle of the true annual ring rather abruptly give way to two or three layers of compressed tracheids with thicker walls and smaller lumina. Outside this belt the tracheids more or less completely assume the form of spring-tracheids with larger lumina and with walls either as thin as those in the spring-wood or considerably thicker. Outside this zone in turn more or less sudden thickening of the walls marks the beginning of the true summer-tracheids (fig. 18).

The walls as seen in radial section widen markedly in contact with the medullary rays.

The ends of the tracheids are more or less sharp, or bluntly rounded, except when they end abruptly on a medullary ray; when ending thus on a ray-tracheid the transverse terminal wall has one or more bordered pits. With this exception and the sporadic occurrence of pits on the tangential and terminal walls, the bordered pits are confined to the radial walls, where in the spring-wood they are uniseriate or biseriate or both in the same tracheid (fig. 26). In each primary pit-area there may be one bordered pit or two collateral ones. Here the bordered pits are circular or oval with the longer axis transverse and the orifices circular, or widely fusiform and with the longer axis directed transversely, obliquely or nearly vertically. In the summer-wood the scantier and smaller pits are circular with a narrow fusiform, nearly erect orifice (fig. 21).

The peculiar structure shown in figure 22 and superficially resembling a deformed bordered pit is a transverse section of a radial bar (Sanio's bar) which streatches across the lumen of the tracheid and perhaps increases in height near its attachment to the tangential wall.

Resin-Ducts.

The resin-ducts may be solitary or paired, and in the latter case separated by only a few layers of flattened thin-walled parenchyma. The ducts have an unusually wide cavity (the width of which attained ·2 mm., while the radial width of the epithelial cells was 13 μ). The cells composing the one-layered epithelium in longitudinal section are short, broad, often elongated transversely and hexagonal in form.

This layer may be wholly or partially enveloped in a sheath of flattened parenchyma.

Surrounding these cells is thin-walled parenchyma, whose cells are brick-shaped, and elongated longitudinally. Such cells are often particularly developed on the side towards the nearest medullary ray, with whose parenchyma they are continuous.

Typical parenchyma-tracheids occur in contact with this parenchyma, and with thick-walled copiously parenchyma-cells that have numerous simple pits (fig. 20).

Medullary Rays.

The uniseriate rays vary in height from 1–25 cells, while the fusiform rays vary from a height shorter than the highest uniseriate up to equal to 30 cells.

In the rays, apart from resinous epithelium, there are three kinds of cells: thick-walled and thin-walled parenchyma, also ray-tracheids.

The *thick-walled parenchyma-cells* are much more abundant than the thin-walled. Each cell is brick-shaped with a transverse or oblique terminal wall. The length equals the radial width of 6–8 tracheids in the spring-wood, and

9–10 in the summer-wood. All the walls are pitted. On the lateral (radial) walls the pits are of moderate size but not nearly equalling the height of the cell ; they are arranged in one or two horizontal series, with 1–3 pits in each series. The outline of the pit is usually very broadly lenticular, with the long axis nearly horizontal or oblique, or nearly circular, but the thickening on the two sides is not exactly similar, so that the pits often show a double outline, the aperture or area being often slightly narrower on the tracheid-side (fig. 24). This distinction is more marked in the summer-wood where the orifice on the tracheid side is narrowly fusiform and nearly erect, and in a vertical direction often longer than the diameter of the chamber, while on the side away from the tracheid the pit orifice is shaped as in the spring-wood (fig. 23). The terminal walls have coarse reticulate thickenings, so that oval, fusiform, or circular pits result. In tangential section, the cell-lumen is mostly oval with the long axis erect in uniseriate rays (fig. 25), but more rounded in fusiform rays. They do not bulge into the adjoining tracheids like thyloses.

The *thin-walled parenchyma-cells* have unpitted terminal walls, which are transverse and bow-like. Towards the tracheid on the radial walls their pits often resemble those of the thick-walled parenchyma, but often are so much larger that in the spring-wood there may be only one pit to the radial width of a tracheid, and this one pit stretches across the whole height of the parenchyma-cell. In the summer-wood the slit-like orifice is often longer that the circular chamber. The upper and lower walls are not pitted. The occurrence of large pits and relatively small bordered pits on the radial walls of ray-parenchyma of one and the same pine, is of special interest in relation to the classification of the genus and the systematic position of *P. longifolia.*

The *ray-tracheids* show bordered pits on all walls. The walls of the marginal tracheids bear denticulations, which sometimes nearly meet across the lumen and are more pronounced in the summer-wood than in the spring-wood. The terminal walls are transverse or oblique. Internal ray-tracheids occur and have curved terminal walls; some are unusually wide and others narrow.

The *uniseriate rays* are usually composed of thick-walled parenchyma (fig. 25) with or without ray-tracheids, but in some cases thin-walled parenchyma forms a considerable part of the ray. Where the ray crosses a resin-duct, thick-walled, starch-containing parenchyma is often but not always replaced by thin-walled, slender brick-shaped cells with more elongated pits on the side walls and entire transverse walls. Neither are ray-tracheids always replaced across the duct by parenchyma, for very slender ray-tracheids are to be seen crossing the duct.

Here and there occur *rays* that are *biseriate* in the middle and uniseriate at the margins, and are devoid of resin-ducts.

A typical *fusiform* ray (fig. 19) consists in the centre of a resin-duct, surrounded by a flattened epithelium, around which in turn is a second similar layer. Above and below succeed (about four) tiers of wide thin-walled starch-containing parenchyma, arranged in a biseriate manner. Next to these are several (2–5) tiers of thick-walled starch-containing parenchyma, arranged in a uniseriate manner. The ray is completed at its margin by 1–3 tiers of uniseriate ray-tracheids. Internal ray-tracheids may interrupt the tiers of thick-walled parenchyma. Less frequently the thin-walled parenchyma is more abundant: for instance, one ray in tangential section consisted successively of 1 tracheid, 2 uniseriate thick-walled parenchyma-cells, 4 uniseriate and two tiers of 2–3-seriate thin-walled parenchyma-cells, 2 layers of flattened cells around the duct, 1 3-seriate and 1 2-seriate and 1 1-seriate tiers of thin-walled parenchyma-cell, a solitary thick-walled parenchyma-cell, and 2 uniseriate ray-tracheids.

PINUS KHASYA, *Royle*.

This three-needled thick-barked species occurs in the Khasia and Naga Hills, as well as in several regions in Burma, at altitudes varying from 7,000 feet to the comparatively low one of 2,500. By Kurz it is described as growing in Burma in dry hot woods forming pure forests or mixed with trees belonging to the "upper dry forests." These pine-woods are well-lighted, rich in epiphytes (especially orchids and lichens), but very poor in lianes. The epiphytes suggest considerable atmospheric humidity at least periodically. The tree thus seems capable of living on dry sunny sites and in a climate ranging from temperate to sub-tropical or even tropical. On the Khasia Hills it does not grow in the regions of very great rainfall (Hooker).

A. MACROSCOPIC FEATURES (naked eye).

The light-coloured "pale brown to red" (Gamble) wood shows distinct annual rings, which in our specimen are somewhat sinuous. In a specimen of which Gamble gives the measurements there were six annual rings to the inch radius; ours showed 3·2. The transition from the spring-wood to the summer-wood is gradual, and the distinction between these two is not great. The numerous resin-ducts of this very resinous wood are most abundant in the outer half of the annual ring, in fact they are almost lacking from the inner third or half: in longitudinal views they form well-marked brown stripes. The medullary rays faintly suggested by ill-defined radial striation in the cross-section, form a delicate silver grain on the radial section.

B. MICROSCOPIC STRUCTURE.

The interesting features in the microscopic structure of the wood are :—

i. There are unusually complete arrangements for the conduction of water in various directions in the body of the wood; for the tracheids may have bordered pits on all their walls.
ii. Some of the tracheids assume unwonted forms.
iii. The resin-ducts and associated parenchyma are very richly developed.

Tracheids.

In transverse section the spring-tracheids are wide and rectangular to hexagonal with the radial diameter exceeding the tangential. Passing outwards there is a very gradual shortening of the radial diameter, and thickening of the walls, until the outermost three or four rows of the summer-wood are flattened. The measurements are given below :—

	SPRING-WOOD.		SUMMER-WOOD.	
	Radial.	Tangential.	Radial.	Tangential.
Width of lumen	52 μ	25 μ	9·2 μ	19 μ
Thickness of wall....	2 μ	2·5 μ	5 μ	5 μ

Mean length of the tracheid 4·6 mm.

In addition to tracheids of normal form, others occur with blunt rounded ends, and near the resin-ducts with transverse rectangular ends, also with feebly bilobed rounded ends. Here and there bundles of tracheids deviate from the straight course, portions of them run in a radial plane obliquely to the longitudinal axis, so that at spots not in contact with the medullary rays tangential longitudinal sections show transverse sections of tracheids (fig. 28). Where the ends of the tracheids abut upon medullary rays from above or below, some end bluntly, others bend and run radially transversely for shorter or longer distances and thus, so far as arrangement is concerned, form transitions between tracheids of the body of the wood and ray-tracheids. This transition is even more remarkably shown by those tracheids which bend into a medullary ray, so that their terminal portions run in a transverse radial direction and their terminal walls end directly against a terminal wall of a ray-tracheid (fig. 34). Other tracheids push their ends between the ray cells, so that in tangential section such tracheids may be seen cut transversely.

The bordered pits are mainly on the radial walls. In the wider spring-tracheids they are uniseriate or biseriate with circular apertures (fig. 35). The biseriate pits are circular in outline or slightly flattened where the pits are in lateral contact. The chambers of the uniseriate pits are often elliptical in contour with the long axis transverse. In the narrow summer-tracheids the radial pits are much scantier, uniseriate, and have oblique narrow fusiform apertures (fig. 36).

In addition to the bordered pits on the radial walls there are others on the oblique lateral walls of tracheids that are hexagonal and pentagonal in transverse section, and on tangential walls of some tracheids (fig. 30). These tangential pits occur in the first place on tracheids that are contiguous with the parenchyma on the radially inner and outer sides of the resin-ducts.

Tangential pits also occur often, if not exclusively, in the bundles of bent tracheids already described, especially or solely near the ends of the obliquely directed portions. Here they are most abundant in the spring-wood though not absent from the summer-wood. Inasmuch as these bent tracheids form radial series and their bent ends are often at approximately the same level, in transverse sections the tangential pits are seen in radial rows. The occurrence of bordered pits on the tangential walls of species of *Pinus* that usually have none has been recorded (see Strasburger), but in such cases the tangential pits appear to be characteristic of unusually narrow annual rings, whereas in *Pinus Khasya* these radial bands of tracheids with tangential pits occur in wide annual rings.

Finally, bordered pits occur on the transverse or bluntly rounded walls of the same types of tracheids that have tangential pits, as well as on tracheids that end bluntly against ray-tracheids (fig. 29).

Sanio's rims are distinct in the spring-wood (fig. 35).

As seen in the radial section, the walls of the tracheids in contact with the medullary rays are thicker than elsewhere, as in the case with resin-tracheids of *Dammara*. As there is no question of resin-tracheids here, the thickening of the wall in *Dammara* may be connected with the proximity to the medullary ray and not with the existence of resin-plates.

Resin-Ducts.

The resin-ducts are most numerous in the outer half of the annual ring, where they tend to form a tangential series as seen in transverse section. Very few isolated ducts occur at the inner boundary of the annual ring. Outside this zone succeeds a spring-zone devoid of ducts.

The ducts in place of being solitary are usually clustered in groups of two, three or even more. Frequently a medullary ray divides the cluster, which often includes two kinds of ducts—normal wide ones and much narrower ones. The diameter of a large resin-duct measured was nearly 80μ and the radial diameter of the epithelium-cells nearly 18μ. The duct itself is walled by a single layer of flattened peripherally extended thin-walled cells which tend to be somewhat elongated in a longitudinal direction. Around these is a collection of thin-walled parenchyma which is more extensive than usual. These cells are more elongated than those walling the duct, and towards the surrounding tracheids are increasingly narrow and long, their walls not being lignified. Where a resin-duct is close to a uniseriate medullary ray, this parenchyma may also form a radial series on the distant side of the ray. Outside the thin-walled parenchyma there occur two other types of cells: thick-walled parenchyma and parenchyma-tracheids. Sometimes the latter are separated from the thin-walled parenchyma by the former (fig. 31). The thick-walled parenchyma-cells are elongated, and on their longitudinal walls occur numerous more or less broad or narrow fusiform simple pits, which are elongated transversely or obliquely. The parenchyma-tracheids are shorter than ordinary tracheids and their bordered pits are considerably smaller than those of the surrounding normal tracheids. Where a tracheid abuts on parenchyma the pit is half-bordered.

Medullary Rays.

The uniseriate rays may reach a height of twenty cells, and the fusiform scarcely exceed this or are shallower. Apart from the resinous epithelium, the rays are mainly composed of ray-tracheids and thin-walled parenchyma, though parenchyma with somewhat thicker walls is not entirely lacking.

The *ray-tracheids* are denticulate, bear bordered pits on all their walls; the terminal walls are transverse or oblique. The length of the ray-tracheid equals the radial width of 3–4 wood-tracheids in the spring-wood, and about 6 in the summer-wood.

The *thin-walled parenchyma-cells* mainly have transverse terminal walls, and in length are equal to the radial width of 5–6 tracheids in the spring-wood, and 3–4 in the summer-wood. On the lateral walls the pits are large and only little less high than the cell itself (fig. 27). There is usually one pit to the radial width of a tracheid, both in the spring-wood and the summer-wood, and in the latter the shape varies from oblong-oval with the long axis usually horizontal to oblique broadly fusiform. In the spring-wood the large pit may be divided into two or rarely into three or four small ones, whose contours are fusiform oval or nearly circular. Passing to the summer-wood, the aperture of the single large pit on the side towards the tracheid gradually narrows and its long axis is increasingly erect (fig. 37): while the aperture and contour on the side of the wall truly belonging to the parenchyma-cell remains broad, fusiform or nearly circular. Occasionally the pit-membrane bulges into the contiguous wood-tracheid. The terminal and upper and lower walls are devoid of pits. In tangential section the cells are, in the uniseriate rays, mostly vertically elongated, being oval-oblong, but more rounded in the fusiform rays.

Parenchyma-cells with slightly thicker walls occur. They differ from the thin-walled cells also in the occasional occurrence of pits in the terminal, upper, and lower walls.

The *uniseriate rays* show marginal and internal ray-tracheids, which may be replaced by parenchyma when crossing a resin-duct. The proportion of parenchyma and ray-tracheids varies. Some low rays are composed entirely of ray-tracheids; in taller rays, too, ray-tracheids may preponderate (fig. 32).

The *fusiform rays* include a small resin-duct which is the central or nearer to the upper or the lower margin. Outside the epithelium is a somewhat similar layer of flattened thin-walled parenchyma, which here and there is interrupted by flattened cells which have thick lignified walls on the side distant from the epithelium. Above and below this tissue the ray is two cells in thickness, but there are only two biseriate layers of cells, which are parenchymatous, either thick-walled or thin-walled. Elsewhere the ray is uniseriate and composed of parenchyma and marginal and internal ray-tracheids (fig. 33).

PINUS MERKUSII, *Jungh. & de Vriese.*

In habitat this two-needled species is the most tropical in Asia, as it occurs in the Philippines and Cochin China, and stretches from Burma southwards to the Malay Peninsula, at altitudes varying from 300 to 3,500 feet, and reappears in Sumatra. As regards supply of moisture the tree appears to be capable of enduring considerable dryness, for it is found in hot dry forests on the Shan Hills, but judging from its distribution elsewhere the species also flourishes on sites where at least atmospheric moisture is abundant. The bark is thick.

A. MACROSCOPIC FEATURES (naked eye).

The yellowish-brown heart-wood shows very sharply marked annual rings, of which there were about eighteen to the inch radius in our specimen, and eleven in the specimens mentioned by Gamble. Thus, in spite of the tropical distribution, growth in thickness appears to be comparatively slow. The reddish-brown summer-wood is sharply and suddenly marked off from the lighter yellowish-brown spring-wood of the same annual ring. The proportion between these two types of wood varies; in our specimen the summer-wood is about equal in quantity to the spring-wood, and is well developed in most annual rings, so that the wood is rather hard and heavy.

The resin-ducts are distinct in cross-section and more abundant in the summer-wood than in the spring-wood: they are marked as brown lines in longitudinal view.

B. MICROSCOPIC STRUCTURE.

Tracheids.

In transverse section the spring-tracheids are rectangular or feebly hexagonal, oblong, with the long axis radial. A marked feature of the spring-tracheids is the unusually large size of the lumina, associated with the moderate thickness of wall. This type of structure with radial elongation of the lumen persists throughout the spring-wood, and is correlated with the 1–3-seriate arrangement of the bordered pits on the radial walls. In the inner summer-wood not only are the walls thicker, but also in transverse section the lumen is rounded and approximately isodiametric or slightly shorter in a radial direction. The shortening of the radial diameter is most marked in the late summer-wood, so that the outermost two layers of tracheids have flattened lumina.

The tracheids normally have typical rounded tips but occasionally show long tail-like continuations. On the medullary rays they terminate with blunt, flat ends or the terminal parts are bent, so that in extreme cases the curvature attains an angle of 180°; thus in longitudinal tangential section transverse sections of these "wood-tracheids" are to be seen in contact with the medullary rays.

One remarkable feature in this typical pine is the extraordinary length of the tracheids, which often attain 7 mm. in length. The mean dimensions of the tracheids are shown in the succeeding table, and they show the very great size of the lumen of the spring-tracheids.

	SPRING-WOOD.		OUTER SUMMER-WOOD.	
	Radial.	Tangential.	Radial.	Tangential.
Width of lumen	68·5 μ	45 μ	10 μ	27 μ
Thickness of wall....	4·9 μ	4·9 μ	6 μ	8·2 μ

The structure of the radial walls and the arrangement of the bordered pits have already been described in the general part of this paper. Here attention may be merely directed to the facts that Sanio's rims sometimes more or less completely surround the pit-bearing patch on the wall (figs. 43, 46, 47), also that they may be visible as oblique lines enclosing a single pit (fig. 46) and even separating two pits at the same level (fig. 48). As the pits become uniseriate near or in the summer-wood and the wall is thicker, Sanio's rims dwindle to mere crescents bounding the upper and lower margins of the pit, or one margin only (fig. 44). Proceeding farther out in the annual ring, even these vanish and no Sanio's rims are visible.

In the summer-wood the pits on the radial walls are scantier and are uniseriate.

The bordered pits on the radial walls of the spring-wood are oval or circular in outline, or slightly flattened where close to a neighbouring pit, and the aperture is circular in outline. But in the summer-wood although the pit is circular in outline the aperture is short, fusiform, and oblique or nearly vertical (fig. 49).

Pits are not entirely wanting on the tangential walls, for they occur both in the spring-wood and summer-wood, more especially near the slightly bent tapering ends of bundles of radially deflected bundles of tracheids, which recall the more extensively bent bundles of *Pinus Khasya*. Occasionally, tangential pits occur on the outer walls of the inmost layer of tracheids of the annual ring.

Bordered pits also occur on the rounded ends of some tracheids. Radial lignified bars, "Sanio's bars," stretching across the lumina of radial rows of tracheids also occur.

The walls of the tracheids, as seen in radial section, are thicker against the medullary rays than elsewhere.

Resin-Ducts.

The resin-ducts are fairly numerous and are almost confined to the summer-wood.

The thin-walled epithelium is surrounded by tissue composed of three kinds of cells :—

i. More elongated parenchyma-cells, with somewhat thicker cellulose-walls, which bear large simple oval transversely extended pits.
ii. Very elongated parenchyma-cells with lignified walls bearing obliquely-directed simple pits that are smaller than those on the thinner-walled parenchyma (fig. 42).
iii. Parenchyma-tracheids whose lateral walls have bordered pits that are circular in outline but have long oblique fusiform apertures. Bordered pits occur also on the transverse terminal walls (fig. 42).

Medullary Rays.

The uniseriate rays attain a maximum height of 17 cells: the fusiform rays are relatively shallow, in fact not so tall as the highest uniseriate rays.

The ray-tissue includes, apart from the resin-ducts, three extreme types of cells: thin-walled and thick-walled parenchyma, and ray-tracheids.

The *parenchyma* is mainly of the thick-walled type. The terminal walls are more or less transverse and include a few rounded simple pits. On the lateral walls, to the radial width of one spring-tracheid there are 1–5 large pits, which are in one tier if 2–3 in number, and are in two tiers if 4–5. When, as is usual, there is only one tier of pits on the radial wall, the height of the pits is not much less than that of the cell. The pits vary in contour from oblong or radially elongated to circular or oval vertically elongated (fig. 50). In the summer-tracheids on the lateral walls there is only one pit to the radial width of one tracheid, and this pit has an oblique oval or a circular outline with a long, narrow, nearly vertical, fusiform aperture, towards the wood-tracheid (fig. 45). The upper and lower walls have numerous simple pits of rounded outline. In some of the rays markedly narrower and broader parenchyma-cells of this type are to be distinguished. The usual length of a cell is equal to the radial width of 4–5 spring-tracheids or 4–6 summer-tracheids. The lateral walls do not bulge into the contiguous tracheids. In tangential section the cell is oval, erect or circular (fig. 39).

The *thin-walled parenchyma-cells* are radially elongated with walls that are not pitted.

The *ray-tracheids* have denticulate walls, and their ends are straight and transverse or oblique, or are convex. The walls often are locally thickened to such an extent that in tangential sections the ray-tracheids present the appearance of fibro-tracheids (see fig. 39). Marginal and internal ray-tracheids occur, and the former often assume peculiar forms, especially in the summer-wood, as the terminal part emits a lateral process which either grows over the next ray-tracheid (fig. 41) or forms a more or less erect cæcum. In the latter case the ray-tracheid in shape and direction is transitional towards a wood-tracheid that applies its bent end to a medullary ray. When passing a resin-duct the ray-tracheid may be replaced by a thick-walled parenchyma-cell, but ray-tracheids are also found crossing a resin-duct: possibly, in this and other species of *Pinus*, the change from ray-tracheid to parenchyma does not take place if the ray is passing a point at which parenchyma-tracheids are in contact with the ray, but does take place if the ray comes into direct contact with parenchyma around the duct.

The *uniseriate rays* vary considerably in composition. All four types of cells occur in them, and the ray-tracheids are internal as well as marginal. One ray for instance showed the following composition (the Roman numbers representing the number of ray-tracheids, and the Arabic representing those of the thick-walled parenchyma): III, 3, IV. 4, III; another showed III, 3, III. Ray-tracheids are evidently well-represented. Some uniseriate rays are composed solely of thin-walled parenchyma and ray-tracheids. A marked feature of these rays is the large size of the intercellular spaces.

It was not possible to get perfect preparations of the *fusiform rays*, as these were all attacked by a fungus. The resin-duct was seen to be surrounded by thin-walled parenchyma, which extends for some distance towards the upper and lower margins, which were composed of ray-tracheids, or partly thick-walled parenchyma (fig. 40).

It is a pleasure to express our thanks to Sir David Prain, F.R.S., and to Mr. R. S. Pearson, Imperial Forest Economist, Dehra Dun, India, for their provision of the specimens used in this investigation.

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EXPLANATION OF THE PLATES.

PLATE **24.**

The magnification is 312, excepting in the cases of Fig. 17 (×520), Fig. 18 (×140), and Figs. 11 & 12 (×240 *circa*), Fig. 31 (×72).

Pinus Gerardiana.

Fig. 1. Fusiform ray, tangential section.
2. Parenchyma and parenchyma-tracheids adjoining resin-duct.
3. Ray-parenchyma in summer-wood, radial section.
4. Medullary ray in spring-wood, radial section.
5. Uniseriate medullary ray, tangential section.
6. Spring-tracheid, view of radial wall.
7. Outer summer-tracheid, view of tangential wall.
8. Summer-tracheid, view of radial wall.

Pinus excelsa.

Fig. 9. Medullary ray in spring-wood, radial section.
10. "Distended" medullary ray, radial section.
11. Medullary ray with lobed marginal ray-tracheids, radial section.
12. Medullary ray with very narrow ray-tracheids, radial section.
13. Fusiform ray, tangential section.
14. Outer summer-tracheid, view of tangential wall.
15. Summer-tracheids, radial section.
16. Spring-tracheids, view of radial walls.
17. Uniseriate ray, tangential section of ray-parenchyma.

Pinus longifolia.

Fig. 18. "Double annual ring," transverse section.
19. Fusiform medullary ray, tangential section.
20. Thick-walled parenchyma adjoining resin-duct and medullary ray, tangential section.
21. Summer-tracheids, radial section.
22. Tangential section showing a transverse section of a "Sanio's bar."
23. Medullary ray in summer-wood, radial section.
24. Medullary ray in spring-wood, radial section.
25. Uniseriate medullary ray, tangential section.
26. Spring-tracheid, radial section.

PLATE **25.**

Pinus Khasya.

Fig. 27. Medullary ray, radial section.
28. Tangential section showing a wood-tracheid cut transversely.
29. Radial section, showing pits on the terminal, radial, and tangential walls of tracheids.
30. Summer-tracheid, showing pits on tangential and radial walls, tangential section.

Fig. 31. Tissue adjoining resin-duct (which lay to the left), longitudinal section.
32. Uniseriate medullary ray, tangential section.
33. Fusiform medullary ray, tangential section.
34. Medullary ray, and bent wood-tracheids, in spring-wood, radial section.
35. Spring-tracheid, radial section.
36. Summer-tracheid, radial section.
37. Medullary ray, showing pits of ray-parenchyma, radial section.

Pinus Merkusii.

Fig. 38. Wall of spring-tracheid, tangential section.
39. Uniseriate medullary ray, tangential section.
40. Fusiform medullary ray, tangential section.
41. Medullary ray with lobed marginal ray-tracheids, radial section.
42. Tissue adjoining resin-duct (which lay to the left), longitudinal section.
43, 46–48. Spring-tracheids, radial sections.
44. Late spring-tracheid or early summer-tracheid showing the last trace of Sanio's rims, radial section.
45. Medullary ray in summer-wood, radial section.
49. Summer-tracheid, radial section.
50. Medullary ray in spring-wood, radial section.

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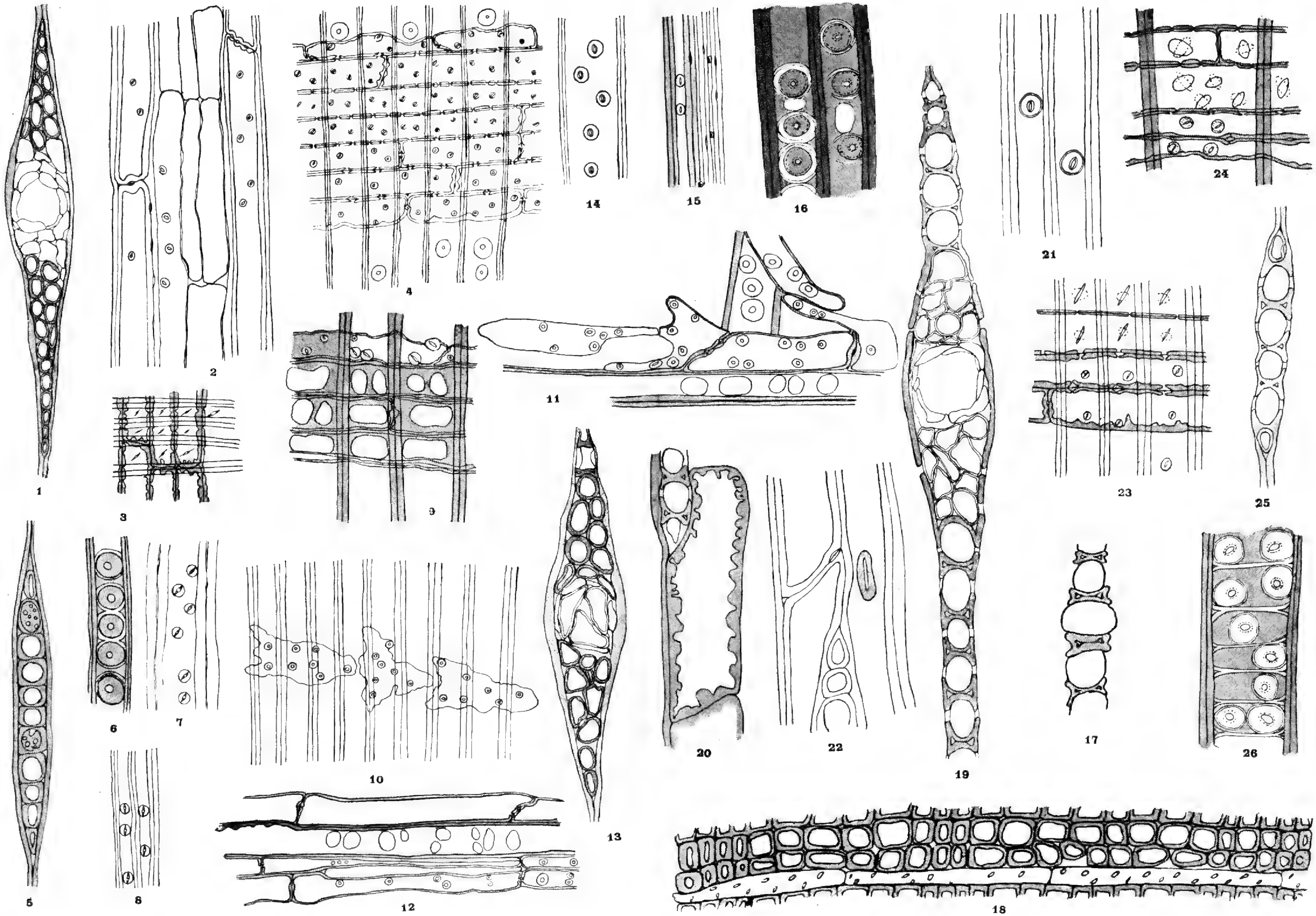

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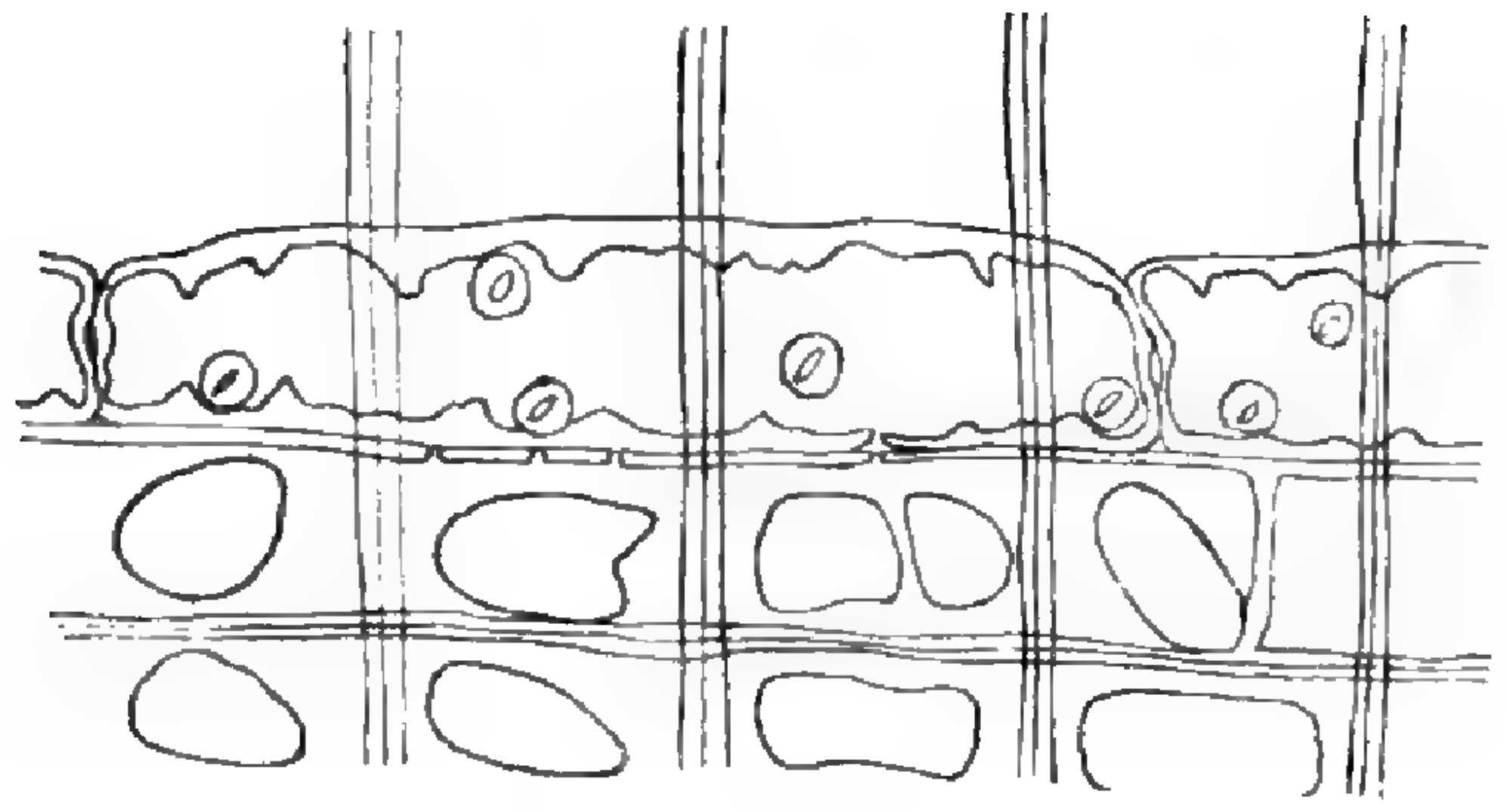
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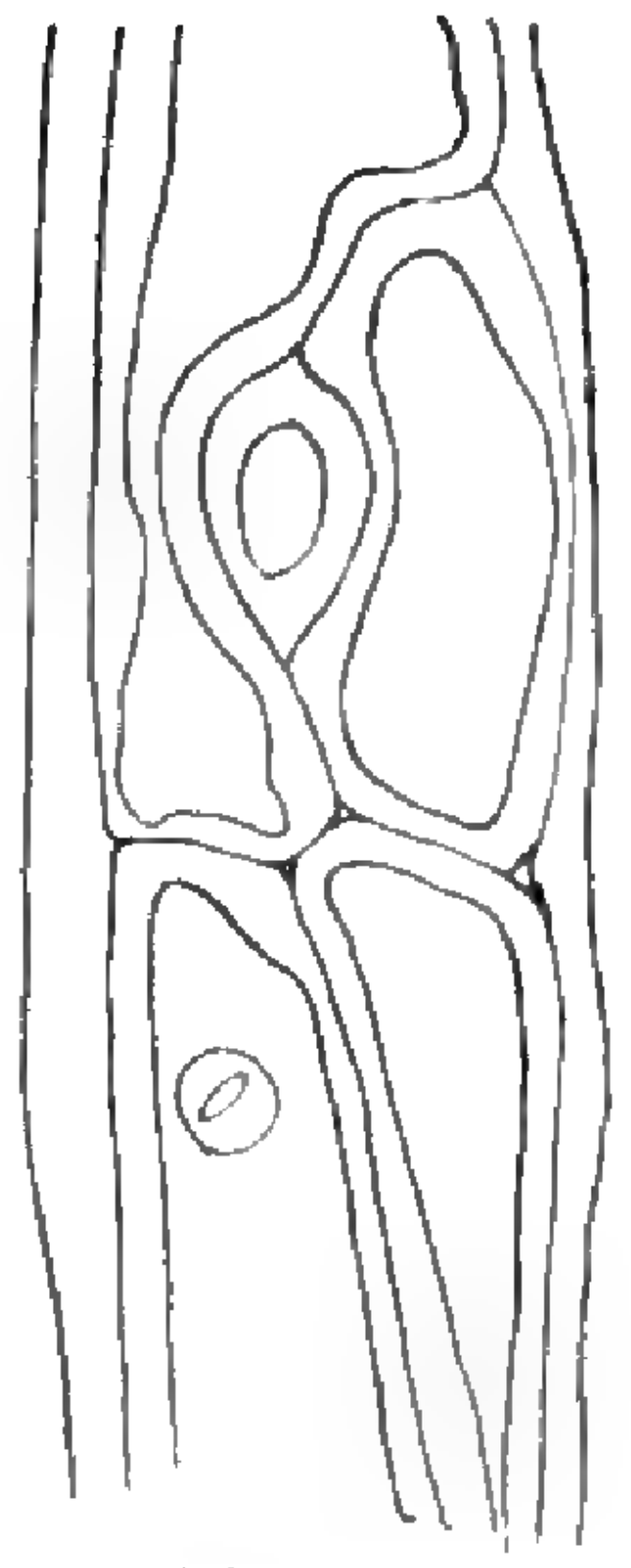
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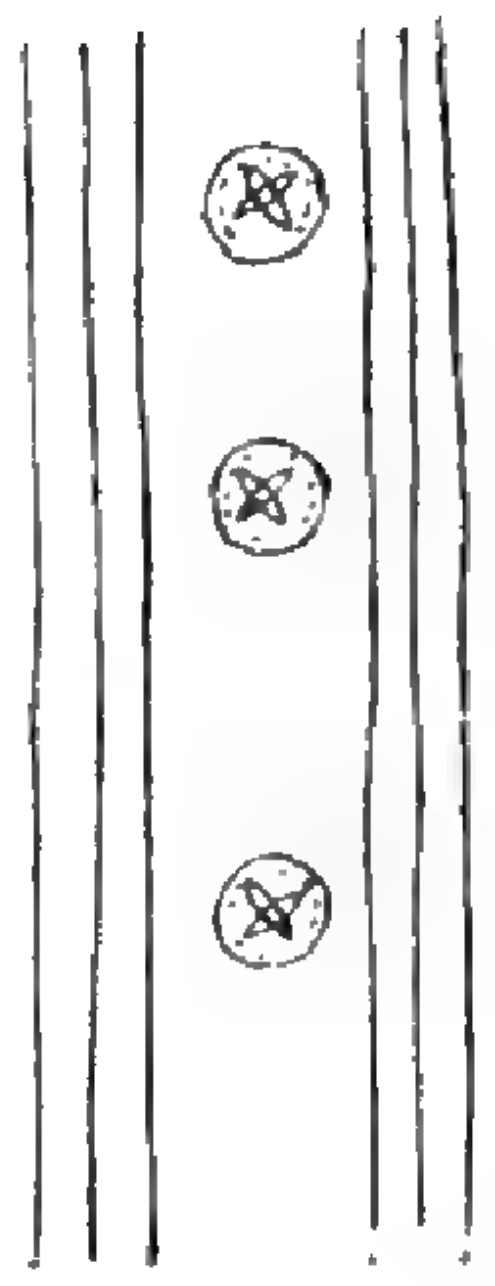
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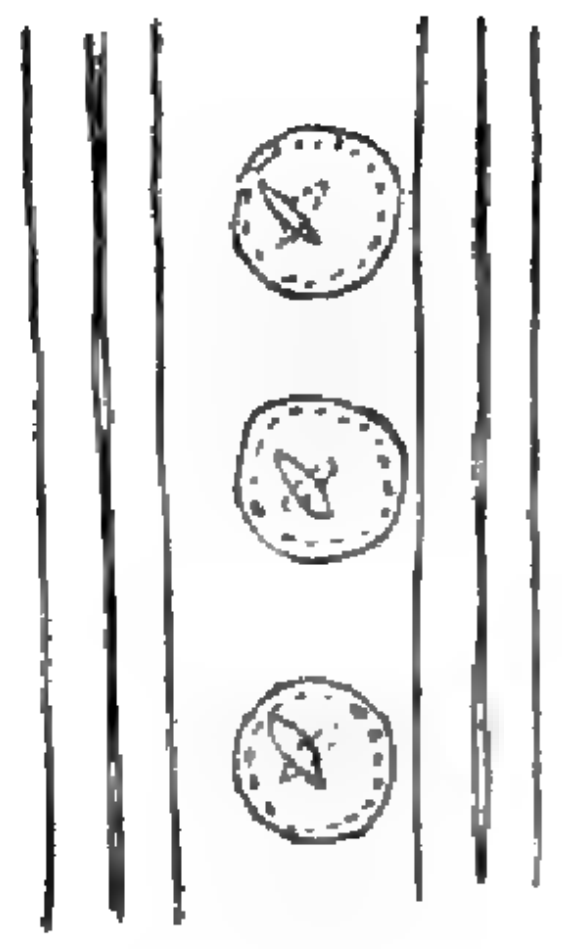
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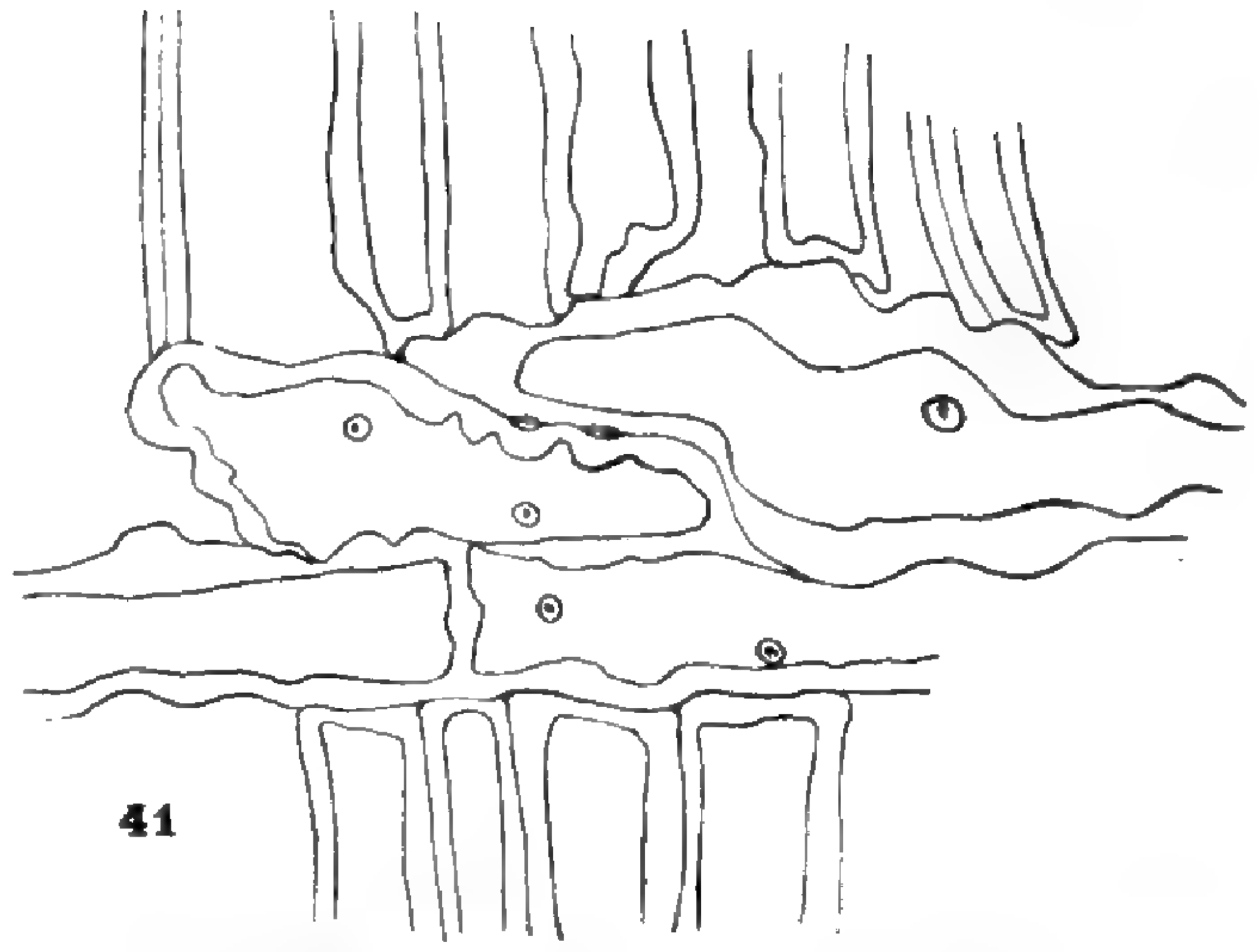
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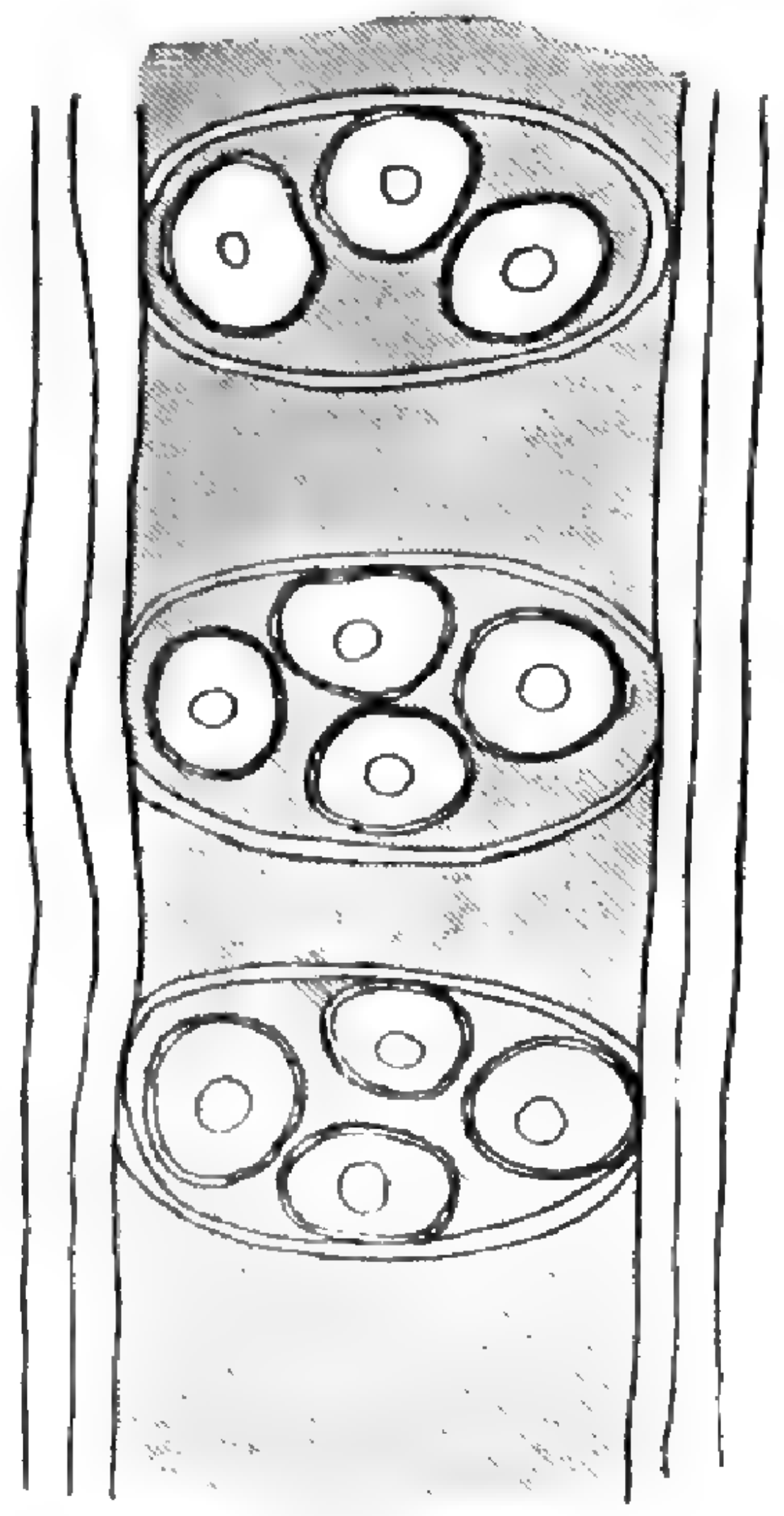
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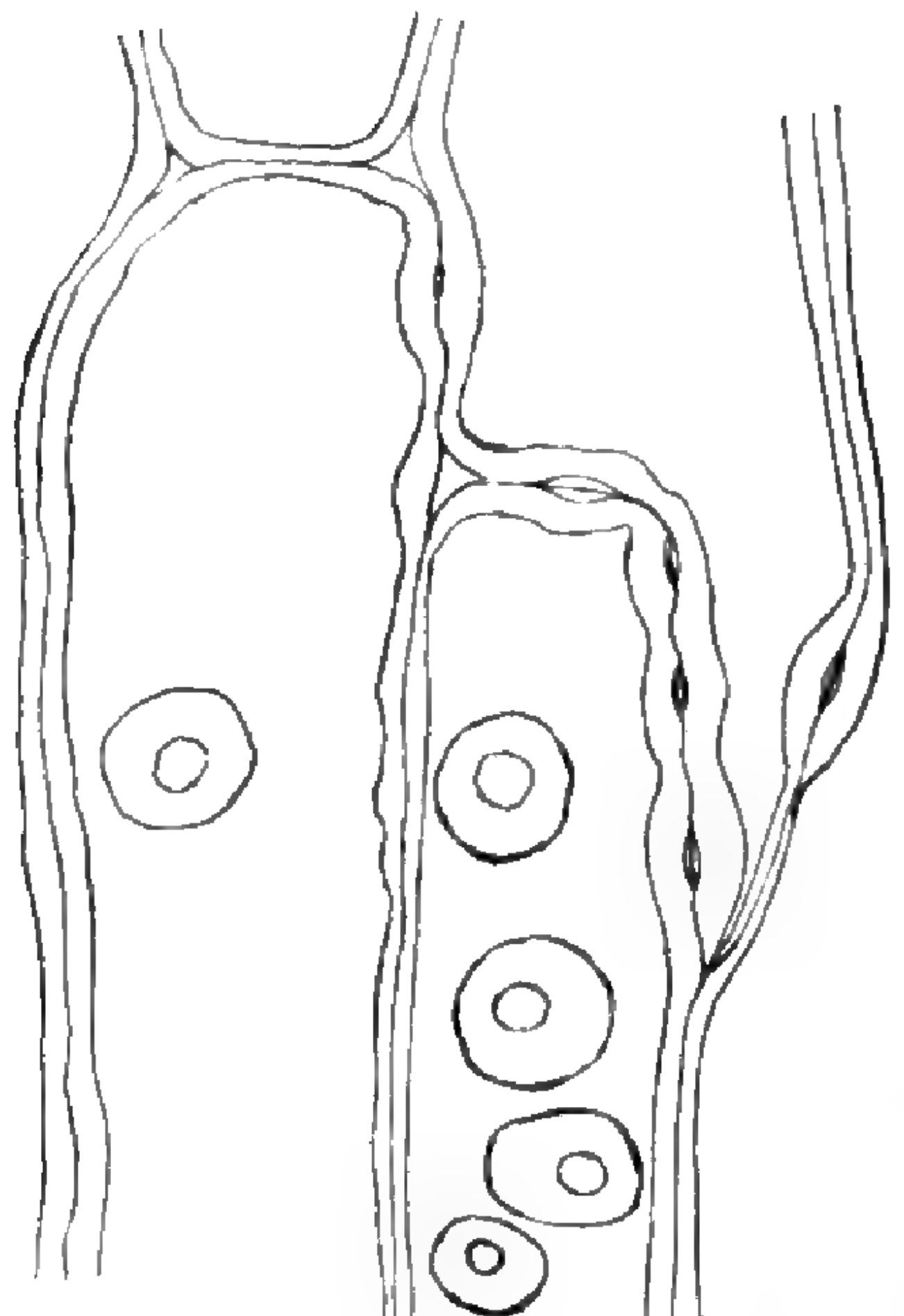
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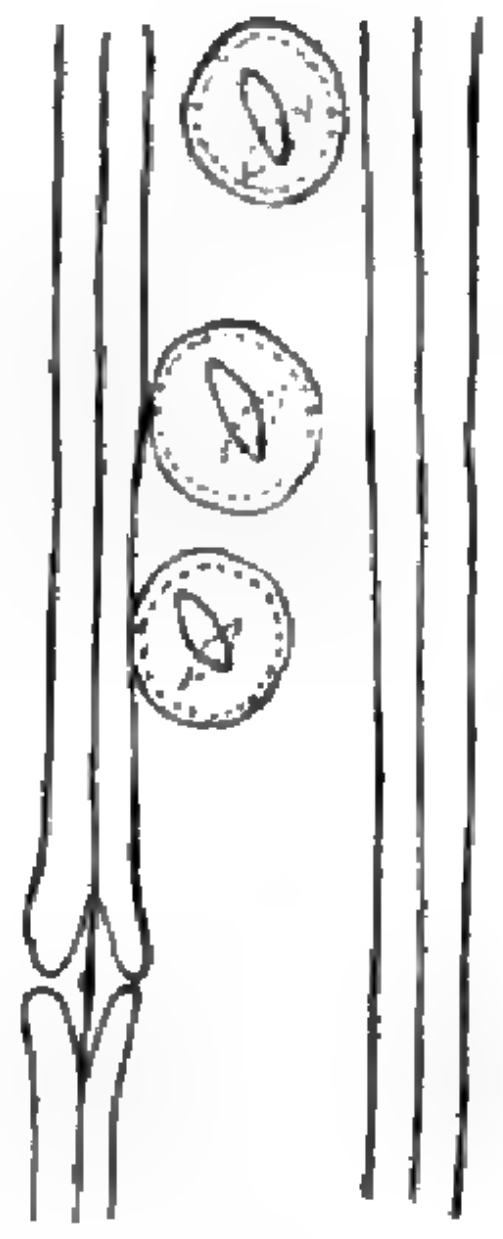
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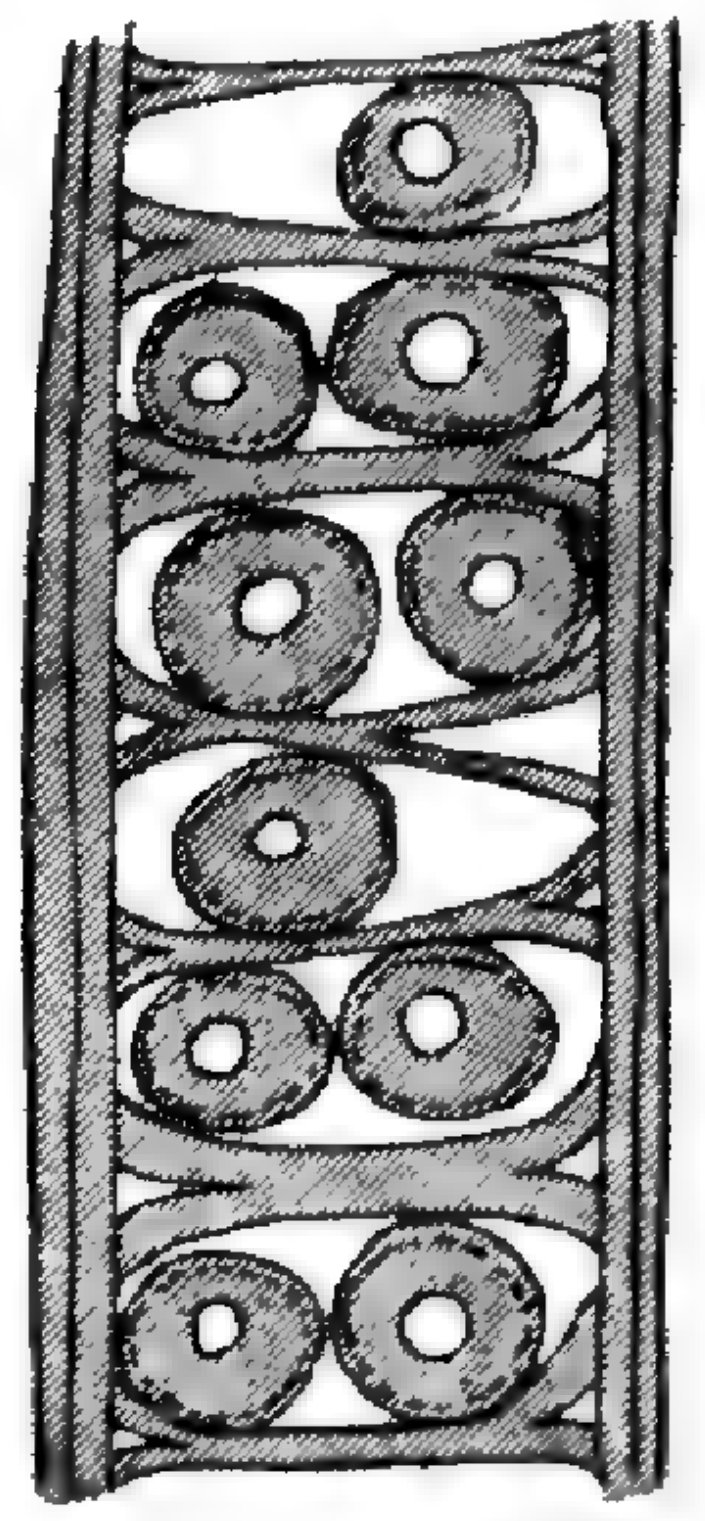
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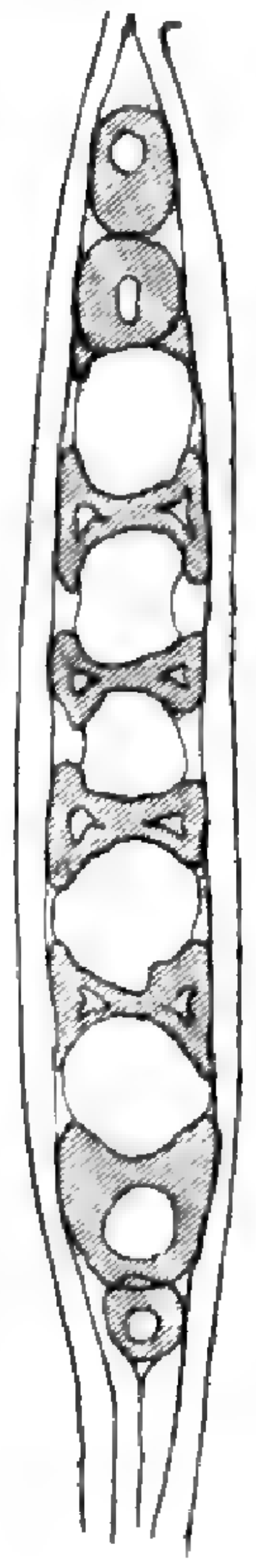
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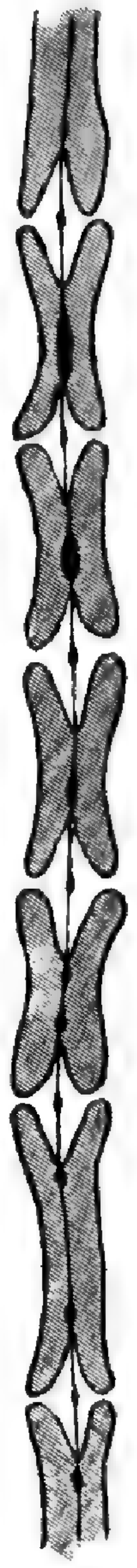
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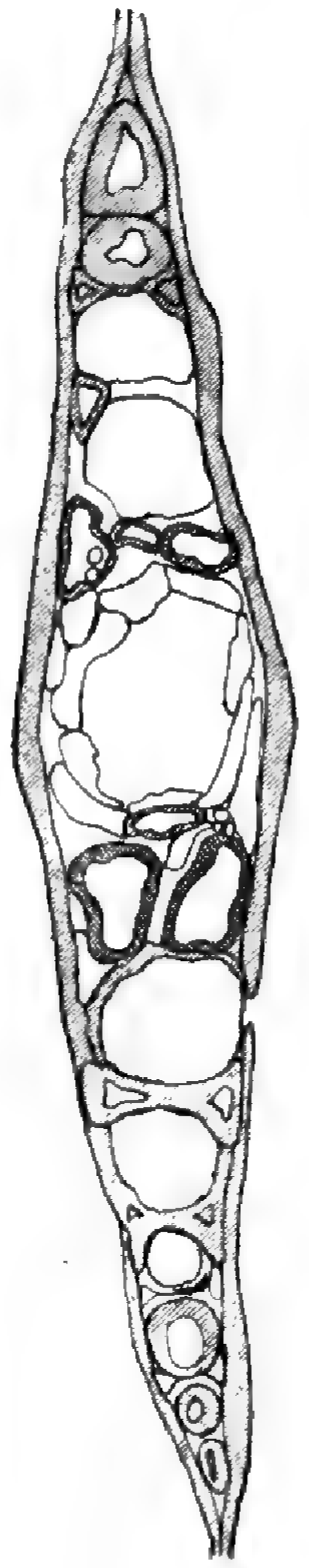
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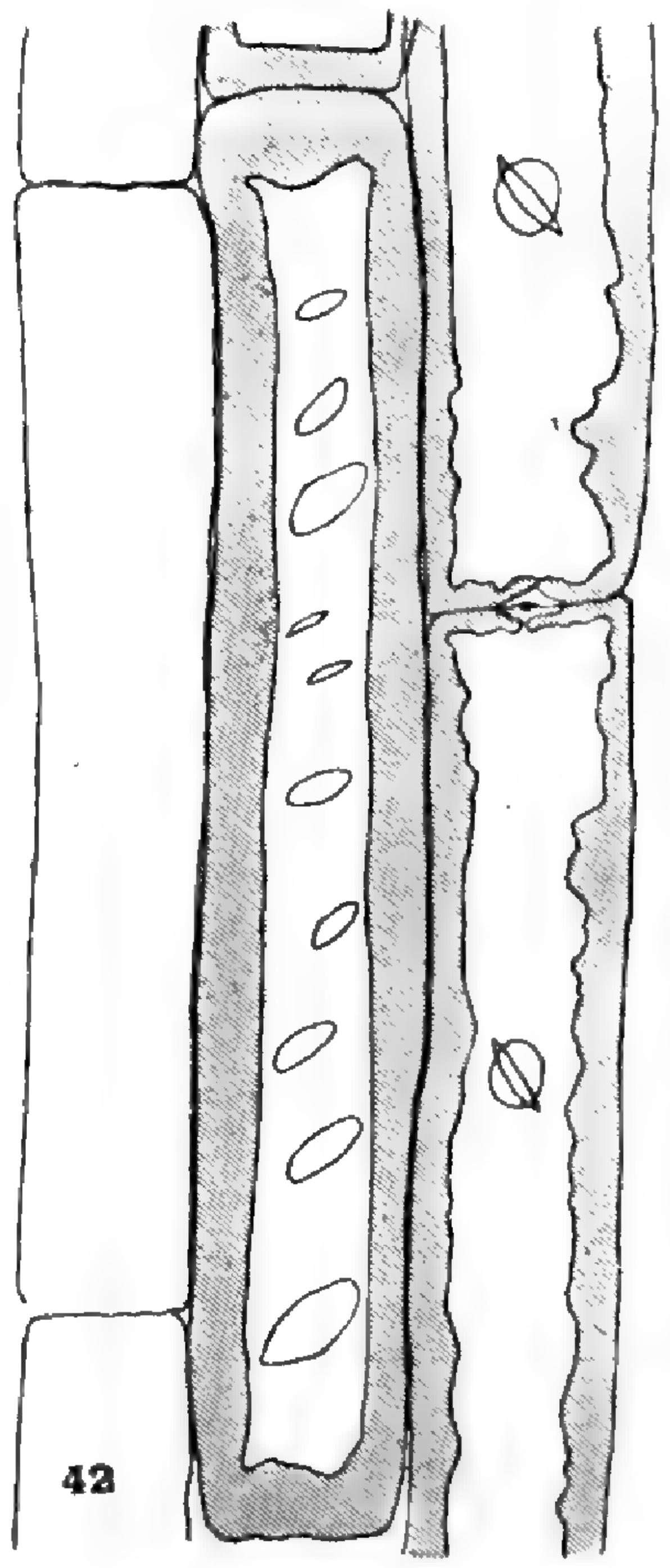
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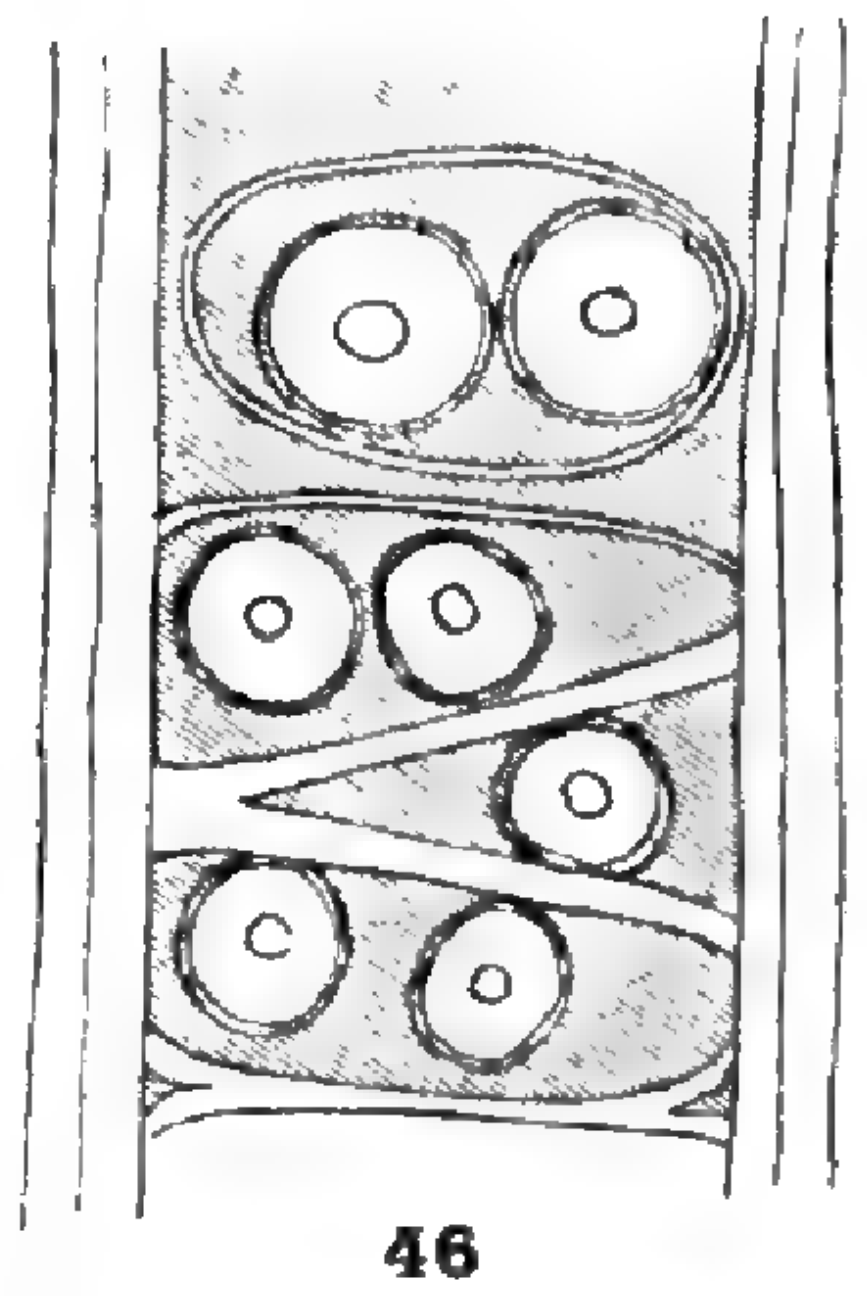
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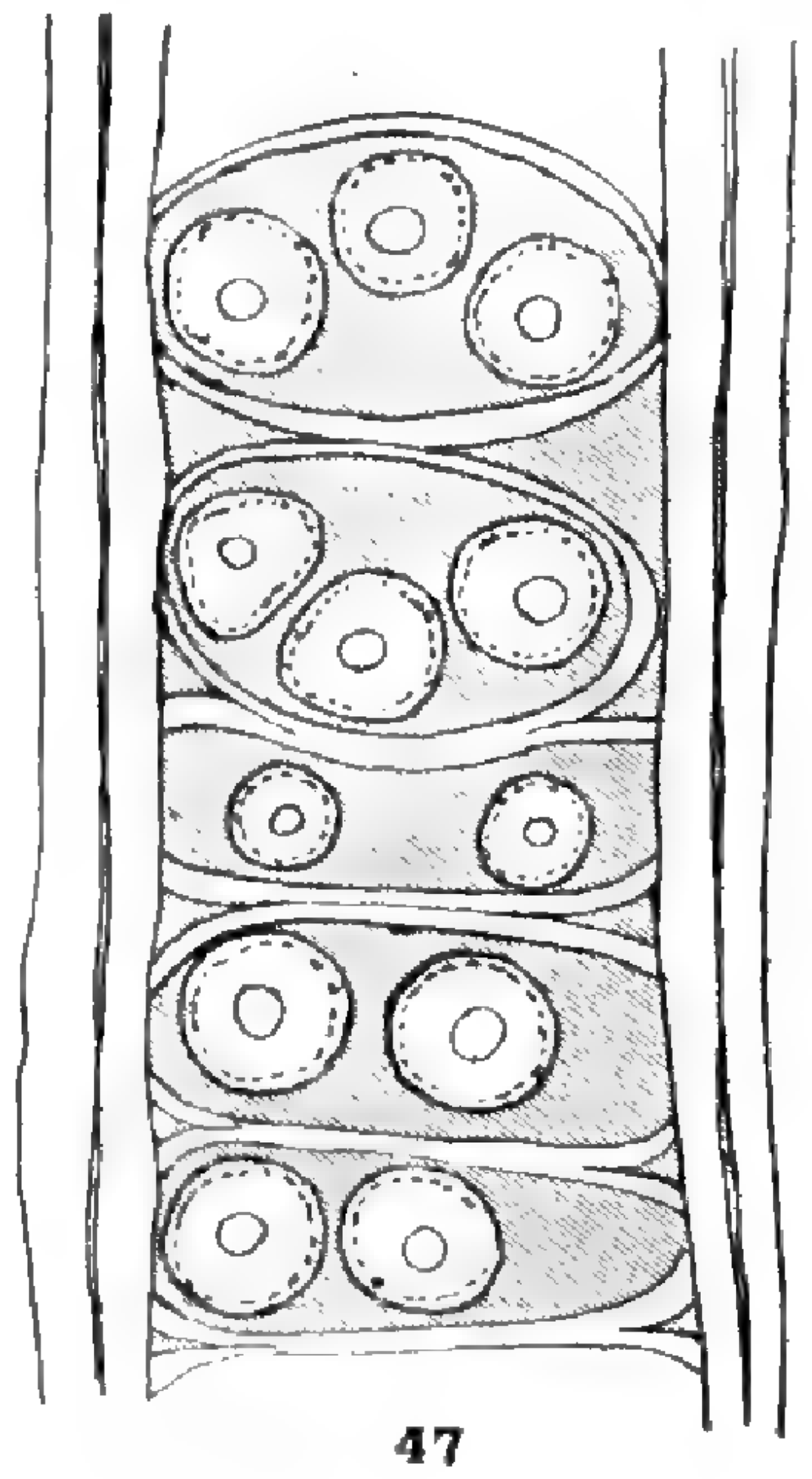
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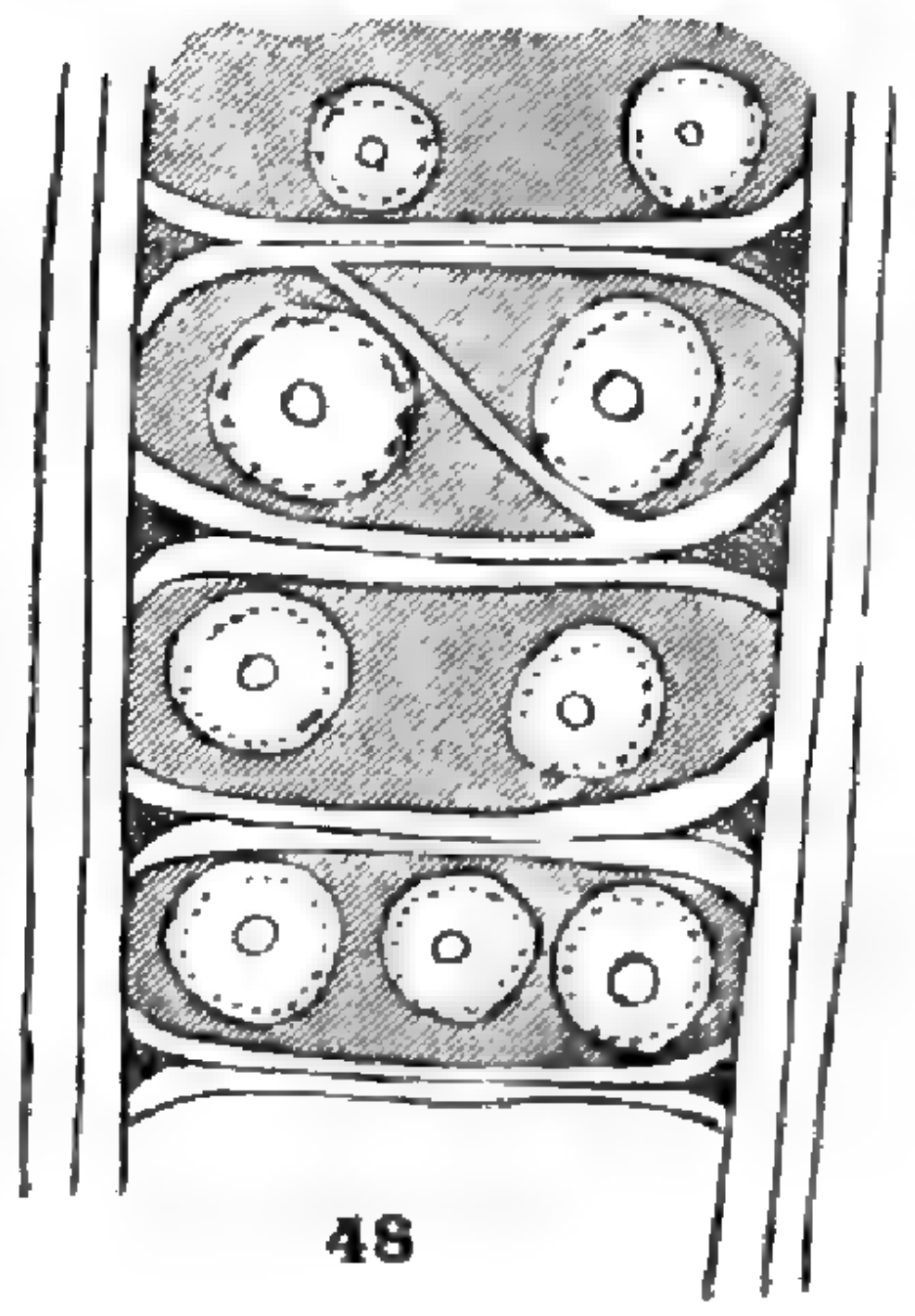
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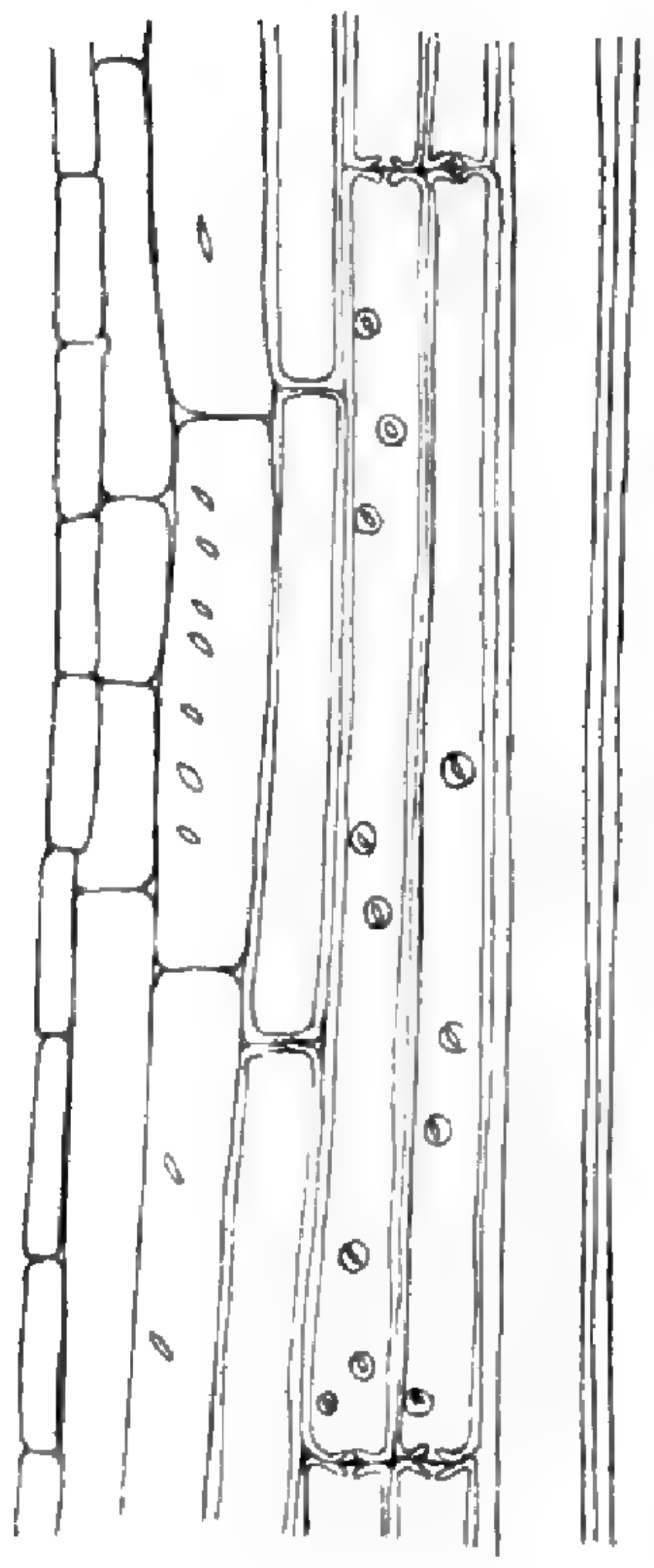
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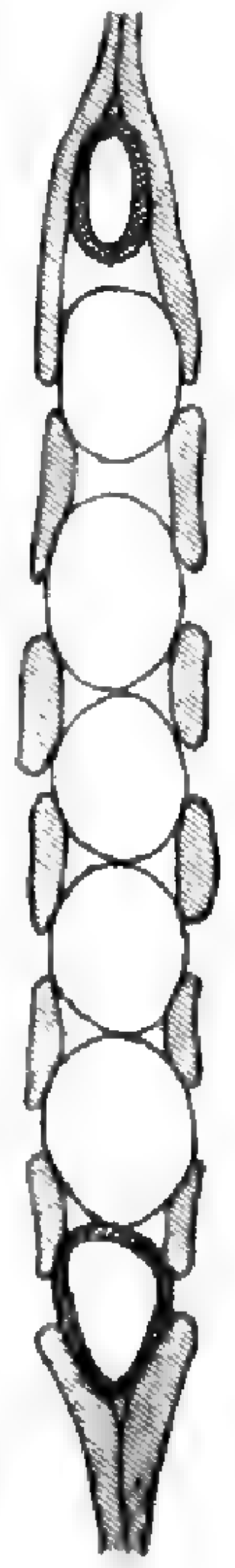
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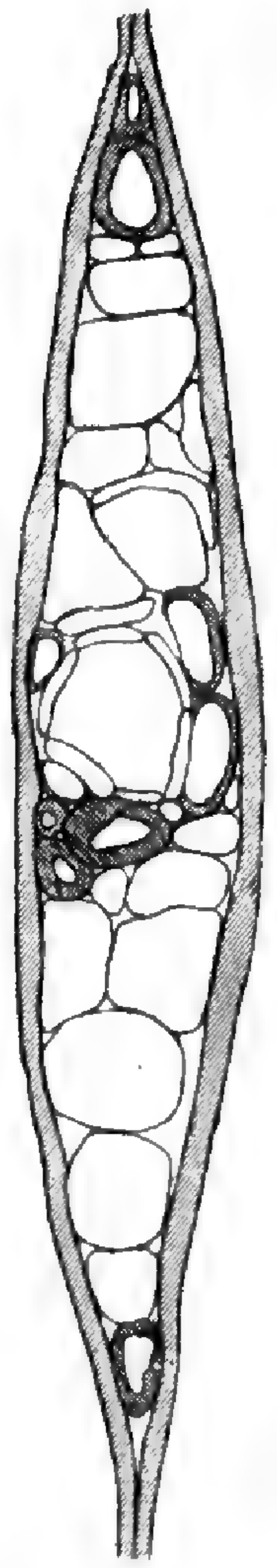
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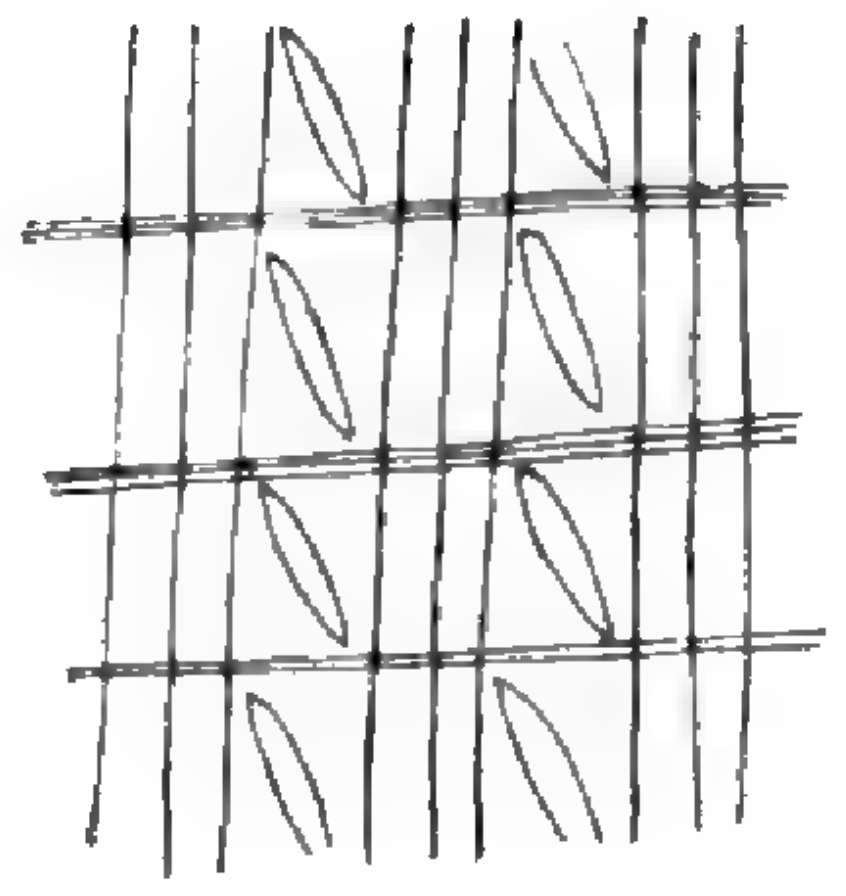
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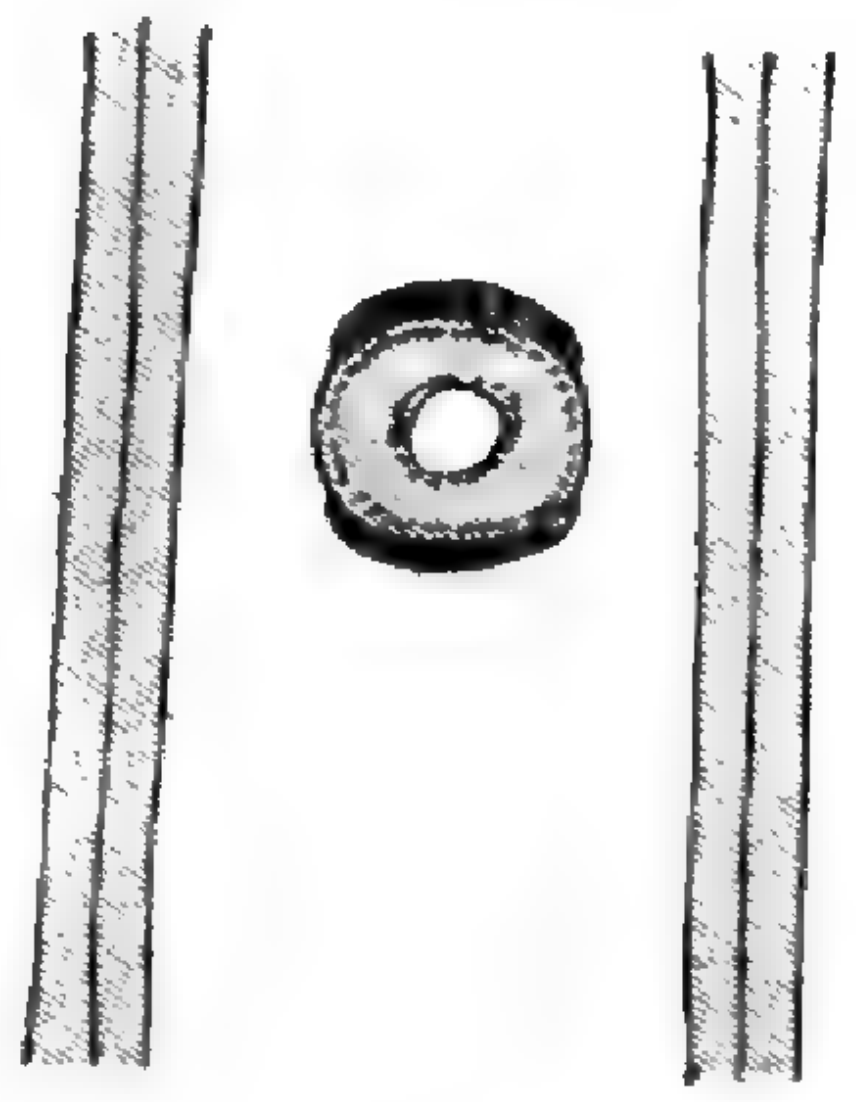
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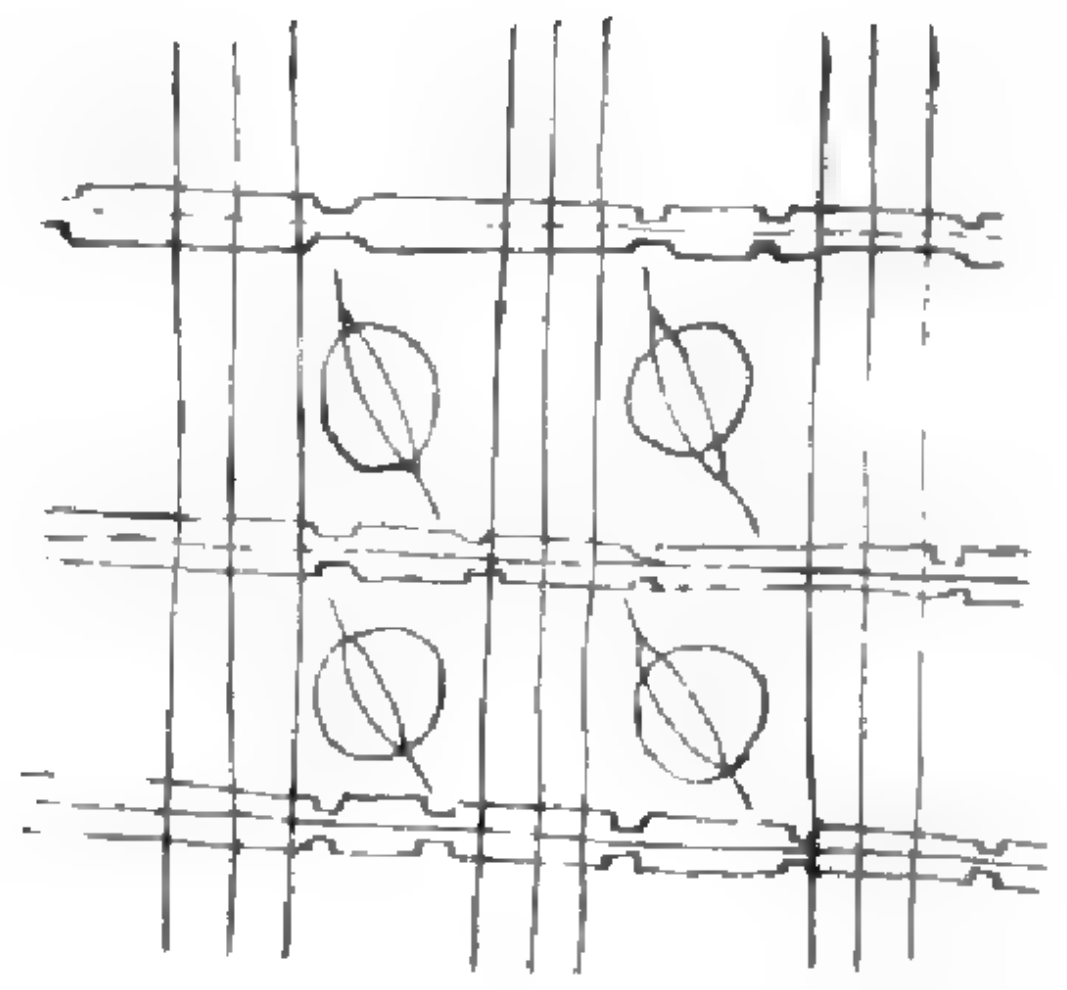
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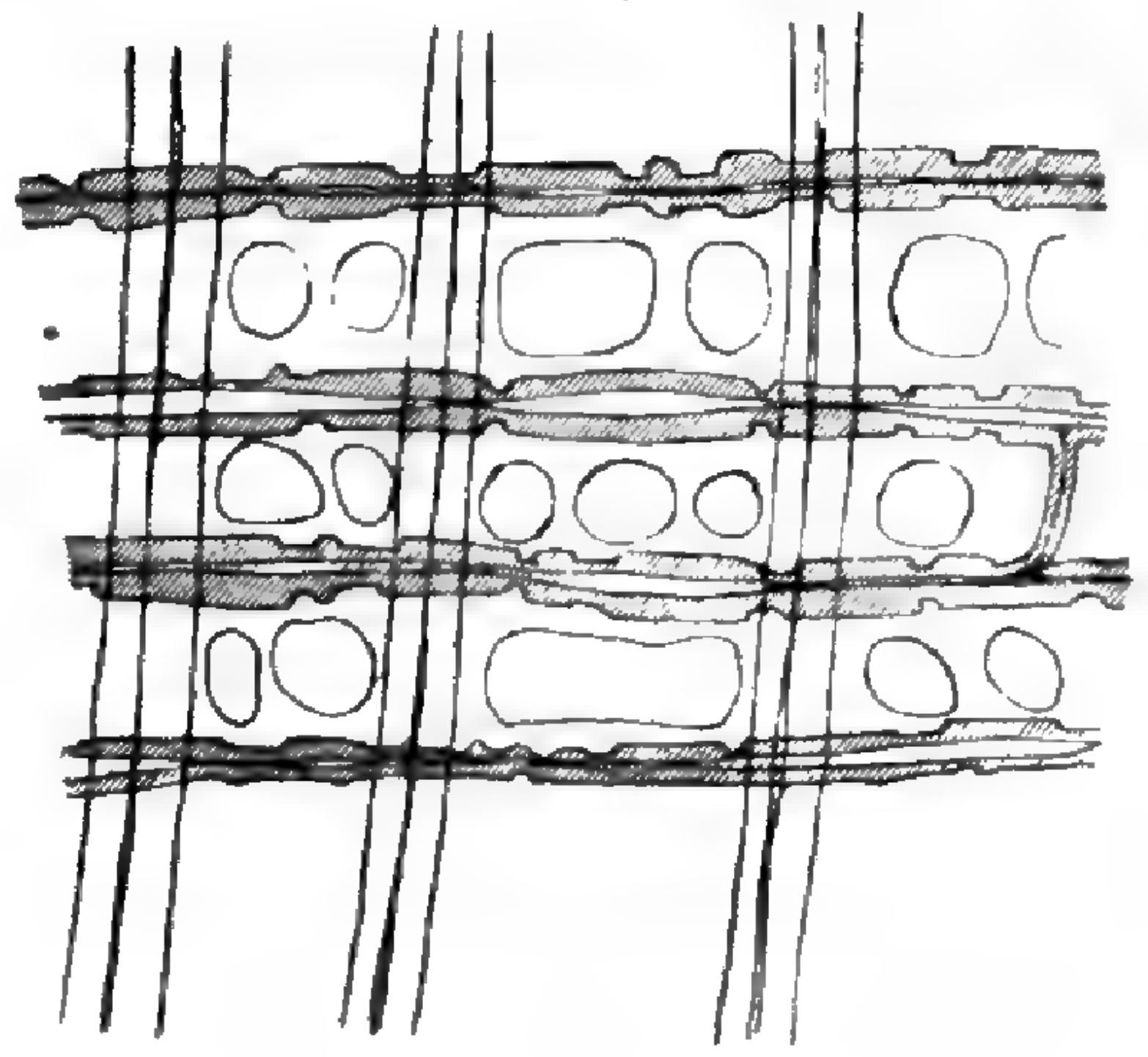
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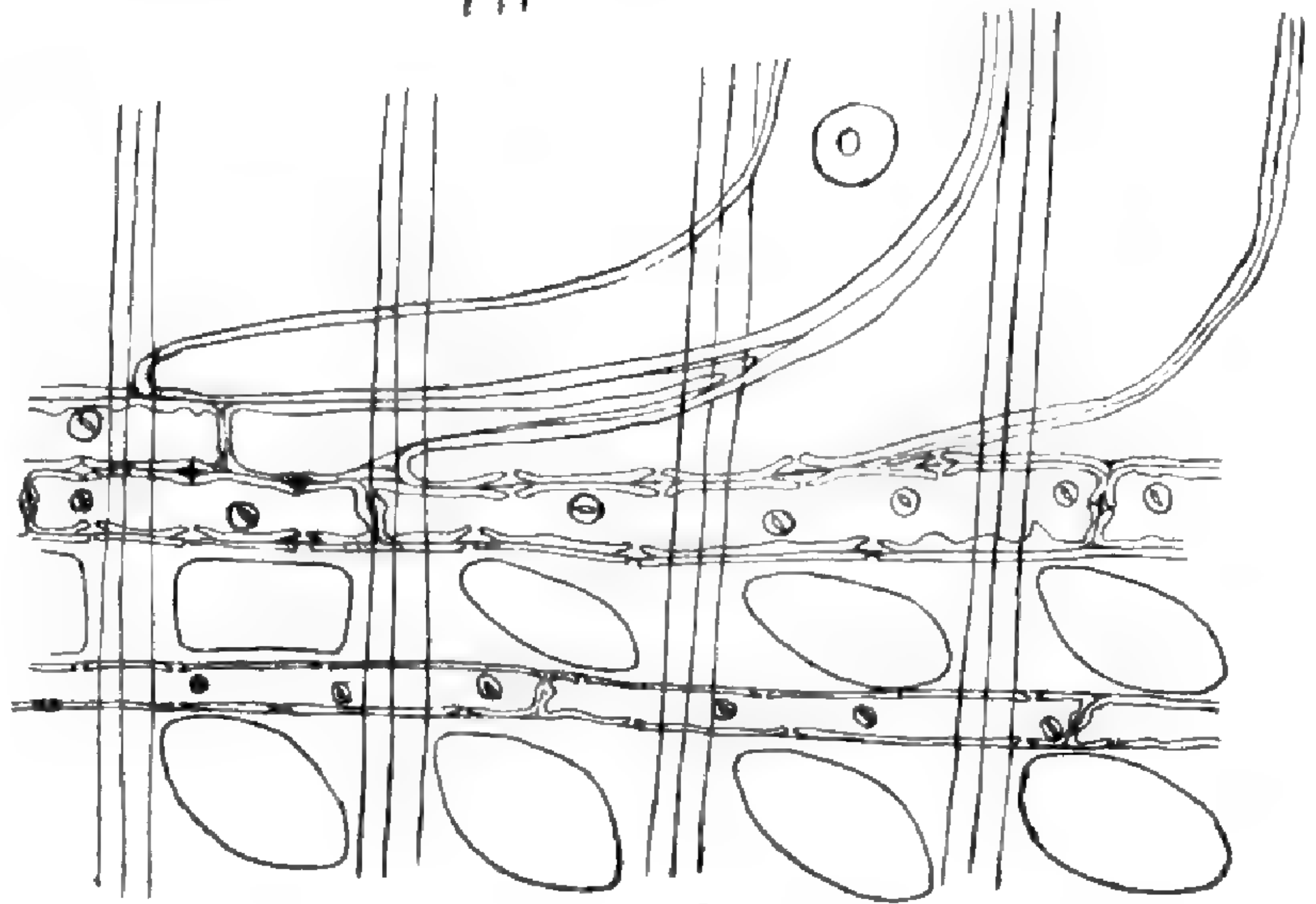
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A Revision of the Genus *Symphytum*, Tourn. By CEDRIC BUCKNALL, Mus.Bac.Oxon. With 2 Text-figures. (Communicated by Mr. J. W. WHITE, F.L.S.)

[Read 19th June, 1913.]

INTRODUCTION.

AN attempt to elucidate the true relations of the native and naturalised species of the genus *Symphytum* which, together with their hybrids, are found in Britain and Scandinavia, showed that considerable confusion existed in the nomenclature, not only of these but of many other species, and that the system of classification hitherto in use, not being in accordance with the natural affinities of the members of the genus, was unsatisfactory. With a view to render, if possible, the identification of these plants less uncertain; to arrange them on a more natural system; and to clear up doubtful points connected with certain little-known species, I determined to make a study of the entire genus. This entailed careful and repeated examination of herbarium specimens and, when possible, of living plants, the study of all the literature of the genus, and of the geographical distribution of the species. In carrying out this work I have had the great and indeed indispensable advantage of free access to the great collections and libraries at Kew and South Kensington, and for this and for much kind assistance my acknowledgments are due to the authorities and to the members of the staff at these institutions. My thanks are also due to Dr. C. E. Moss of Cambridge and to Mr. G. C. Druce of Oxford, for entrusting me with the valuable collections of *Symphytum* in their charge, and to Mr. Clarence Bicknell and Mr. Charles Bailey for the loan of their own large collections. Living at a distance from London, and being unable to spend more than a few days at a time in the National Herbaria, these collections have been of inestimable advantage in enabling me to study at leisure almost all the known species. Through the kindness of M. Casimir De Candolle, M. G. Beauverd, and Dr. John Briquet, I have been enabled to examine the types contained in the great herbaria of Geneva, and to take notes of many interesting specimens. Lastly, I wish to thank those who have so kindly sent me plants, both living and dried, from many parts of Great Britain.

In this revision all citations, whether of authors or of specimens, are given in historical order, and with a view to preserving this order throughout I have not given separate citations of figures. All citations of authors are from the first editions of the works in which they occur.

When I have felt compelled to adopt names differing from those hitherto in use, or to restore to specific rank plants which had been reduced to varieties, I have only done so after the most careful consideration.

For the sake of uniformity of treatment, all descriptions have been rewritten, retaining, however, the characters given by the original authors, and adding alternative characters when these have been found to vary in authentic specimens. But, having given a complete generic description, I have omitted from the specific descriptions those characters which are common to all the members of the genus.

GEOGRAPHICAL DISTRIBUTION.

The geographical area of the genus includes almost the whole of Europe (except Lapland), Asia Minor, a part of Siberia, and Persia. In altitude it ranges from sea-level to 8000 ft., the Caucasian species (*S. caucasicum*, Bieb., and *S. grandiflorum*, DC.) attaining 7000 ft., and *S. asperum*, Lepech., and *S. peregrinum*, Ledeb., 8000 ft. *S. officinale*, Linn., extending from the west of Europe into Siberia over 74° of longitude and 24° of latitude, has the widest range of all. That of *S. tuberosum*, Linn., comes next in extent, but falls far short of *S. officinale*, extending from Spain to the Black Sea and from central Germany to Turkey, with a small outlying area in the north of England and Scotland. Reckoning from north-west to south-east, *S. bulbosum*, Schimp., *S. uliginosum*, Kern., *S. Zeyheri*, Schimp., *S. ottomanum*, Friv., *S. cordatum*, Waldst. & Kit., *S. tauricum*, Willd., *S. anatolicum*, Boiss., *S. orientale*, Linn., *S. brachycalyx*, Boiss., and *S. palæstinum*, Boiss., occupy larger or smaller areas in central and southern Europe and in Asia Minor, sometimes distinct and sometimes overlapping. Of these, *S. palæstinum* reaches farthest south, to about 31° N. lat. *S. armeniacum*, Bucknall, appears to extend from Armenia to the Caucasus. *S. asperum*, Lepech., *S. caucasicum*, Bieb., and *S. grandiflorum*, DC., are found in the Caucasian region, and *S. peregrinum*, Ledeb., in the extreme south-east of the Caucasus and in Persia. *S. mediterraneum*, Koch, and *S. floribundum*, Shuttlw., occur only in a few spots in south-east France, and *S. Gussonei*, Schultz, is probably confined to Sicily. *S. pseudobulbosum*, Azn., *S. Bornmuelleri*, Bucknall, *S. sylvaticum*, Boiss., *S. sepulcrale*, Boiss. & Bal., and *S. kurdicum*, Boiss. & Hausskn., have as yet only been met with in small areas in Asia Minor. As some of the species found in the last-named region bear considerable resemblance to each other and to some better known species, they may be easily overlooked. Their areas will perhaps be extended and other species discovered when the botany of this large and only partially explored region becomes better known. As an instance of the way in which a plant may escape notice even in a comparatively well-known country, *S. pseudobulbosum* may be mentioned. This was found on the Asiatic side of the Bosphorus, near Constantinople, and must be, when growing, a distinct-looking plant. But it was only recognised as a species in 1892, although *S. orientale* had been known near that city since the time of Tournefort.

HISTORY.

The earliest species of *Symphytum* on record are naturally those which are most common and widely distributed in western Europe, viz. *S. officinale*, Linn., and *S. tuberosum*, Linn.

S. officinale is recorded in Turner's 'Libellus' (1538) as "Symphytum herbarii vocant consolidam majorem vulgus Comfrey," and in L'Obel's 'Historia' (1576) as Consolida major.

S. tuberosum still retains the name under which it was known before the time of L'Obel, but is described without a name in Gerard's 'Herball' (1597) as follows:—"There is another kinde of Comfrey that hath leaves like the former (*S. officinale*) saving that they be lesser; the stalks are rough and tender; the flowers are like the former, but that they be of an overworne yellow colour; the roots are thicke, short, blacke without and tuberous."

The *S. tuberosum minus* of Clusius (Stirp. Pann. Hist. p. 671 (1583)) is said to be the plant now known as *S. bulbosum*, Schimp., but the figure, found also in the 'Historia' of 1601, shows neither the characteristic root nor the exserted corolla-scales of that species. The plant was described by Schimper as *S. bulbosum* in 1826.

During Tournefort's travels in the East in 1700–1702 he discovered two species which were recorded in his 'Corollarium' in 1703. One of these, "S. Constantinopolitanum .... flore albo" was figured and fully described in the 'Voyage du Levant' (1717), and is *S. orientale*, Linn., as now understood. The other, "S. orientale .... flore caeruleo" may include two or more species. One of these is represented by a specimen in *Herb. Mus. Brit.*, marked on the back of the sheet "Cappadocia, Tournefort." This has been named "S. orientale," but it is the common plant of the Caucasus described as *S. asperum* by Lepechin in 1798, and by Donn as *S. asperrimum* (Bot. Mag. t. 929) in 1806. It was introduced into England in 1801, and there is a specimen in *Herb. Mus. Brit.* grown at Kew in 1803.

I have lately found amongst Sherard's plants in the Fielding Herbarium a plant labelled "Symphytum Cappadocicum folio subrotundo aspero flore cæruleo, Cor. I. R. H. 7." This was probably collected by Sherard, who was a pupil of Tournefort, if not by Tournefort himself, and is identical with a plant discovered in the neighbourhood of Trebizond by Balansa in 1866. This was named *S. sepulcrale* by Boissier, and was described in the 'Flora Orientalis' in 1879.

There is in the *S. tuberosum* cover in Herb. Linn. a glabrous narrow-leaved plant belonging to the group of *S. officinale*, marked on the back of the sheet "S. vulgare, Gmelin," but with no other indication of its origin. In Smith's herbarium there is a similar specimen. This plant was described by Kerner in 1863, from Hungarian specimens, as *S. uliginosum*. It has been found, doubtless as an introduced plant, at Sefton Park, Liverpool.

S. tuberosum, Ucria, Hort. Reg. Pan. (1789), non Linn., is quoted by Gussone as *S. Zeyheri*, Schimp. This was recorded by Gussone in Prod. Fl. Sic. (1827) as *S. bulbosum*; it was, however, separated from that species by Schimper in 1829.

S. tauricum was described by Willdenow in 1799, and by Hornemann (as *S. bullatum*) in 1813. When introduced into England it became known by both these names, and was figured in the Botanical Magazine in 1816.

S. cordatum, Waldst. & Kit., was also described in 1799, and beautifully figured in the authors' 'Descriptiones Plantarum rariorum Hungariæ' in 1802. It was again described by Persoon in 1805 as *S. pannonicum*, and by Baumgarten in 1816 as *S. cordifolium*.

The name *S. cordatum* was likewise used by Marschall von Bieberstein, in 1808, for a nearly allied but very distinct plant, *S. grandiflorum*, DC. This was discovered by Steven in Imeritia in 1805, and named by him *S. ibericum*, but it does not appear that he published the name until 1819, or the description until 1851. In the meantime De Candolle, in the 'Prodromus' (1846), described it from specimens sent by Wilhelms from Iberia (Province of Tiflis), as *S. grandiflorum*, and this name therefore has priority. I have seen living plants of this species, unnamed, in the botanic gardens of Cambridge, Bristol, and Geneva.

S. caucasicum was described by Marschall von Bieberstein in 1808, and as *S. racemosum* by Roemer & Schultes in 1819. It was introduced into Britain in 1830, and is occasionally found seminaturalised or as an escape.

S. ottomanum was described by Frivaldszky in 1836.

S. palæstinum was described by Boissier in the 'Diagnoses' in 1844, but specimens exist which were collected by Guillardot in the Antilibanon in 1817, and by Aucher-Eloy in the neighbourhood of the Taurus in 1837. Some of these have since been named *S. orientale β. angustior*, DC., but they are quite distinct from any form of *S. orientale*. Others have been referred to *S. asperrimum* and *S. anatolicum*.

S. peregrinum was described by Ledebour (Ind. Sem. Hort. Dorp., 1820), presumably from plants from the province of Talysch in the extreme south-east of the Caucasus. Specimens exist which were grown in the Geneva Botanic Gardens between 1820 and 1830, and this species was subsequently introduced into Britain and Scandinavia as a fodder-plant. It is now extensively naturalised in these and other countries, and has even been cultivated with more or less success in India and Australia (see Report on the Progress and Condition of the Royal Gardens, Kew (1878), p. 12). Remarks on the uncertainty which has existed with regard to the status of this plant will be found on pp. 518–519.

S. anatolicum, Boiss., was collected by D'Urville in the island of Cos in 1820 as *S. asperrimum*. It was again found by Boissier near Smyrna in 1842, and described by him as *S. anatolicum* in 1844.

There is in the Cambridge Herbarium a specimen of a blue-flowered plant collected by Calvert in Armenia between the years 1854 and 1866. It is related in some respects to *S. asperum* and in others to *S. sepulcrale*, but is distinct from these and from all other species. The Fielding Herbarium contains several good specimens of the same plant collected by the Hohenackers in 1831 and 1838 in Georgia, and also another of Calvert's Armenian collection. I have named and described the plant as *S. armeniacum*.

A plant collected by Pinard in Caria in 1843 as *S. orientale*, Linn., was named *S. brachycalyx* by Boissier in 1844.

S. Gussonei, Schultz, was at first referred by Gussone in 'Flora Sicula' (1844) to *S. mediterraneum*, Koch, but was named *S. Gussonei* by Schultz in 1874, because it was not the same as the plant referred by him to *S. mediterraneum* (*S. floribundum*, Shuttlw.). The available evidence tends to show that Gussone's plant is distinct from that of Koch.

S. sylvaticum, Boiss., was gathered by Bourgeau at Calia near Trebizond in 1862, and described by Boissier in 1879. I know of no other specimens than those contained in the Boissier herbarium, and the plant does not appear to be recorded from any other locality.

S. kurdicum, Boiss. & Hausskn., was discovered in Kurdistan near the Persian frontier in 1867 and described by Boissier in 1879. It was again collected by Bornmüller in 1893.

S. floribundum, Shuttlw., was discovered at Hyères by Shuttleworth in 1871. As already mentioned, Schultz determined it to be *S. mediterraneum*, Koch, a plant to which, as I shall endeavour to show, it is in no way related. It appears to be a very rare species, as, besides the Hyères specimens, which are well represented in herbaria, I have only seen it from Aups, Var. All the particulars which I have been able to discover will be found in the remarks on this species.

A plant collected by Bornmüller in the north of Asia Minor in 1889 was distributed under the name of *S. brachycalyx*, Boiss. It is nearly related to that species and also to *S. palæstinum*, Boiss., but occupies an area distinct from that of either species, and possesses well-marked characters of its own. I have therefore described it as a new species and named it *S. Bornmuelleri*, after the discoverer.

S. pseudobulbosum, Aznavour, was discovered near Constantinople in 1892 and described in the following year. It does not appear to have been noticed elsewhere.

Of *S. sicyosmum*, Candargy (Bull. Soc. Bot. Fr. xliv. 1897, p. 150) I have seen no specimens, and the description being so nearly that of *S. anatolicum*, I am unable to distinguish it from that species.

SYMPHYTUM.

Tournefort, Inst. p. 138, t. 56 (1700); Linn. Gen. ed. I. p. 39, no. 109 (1737); Engler & Prantl, Pflanzenfam., Borrag. Teil iv. Abteil 3*a* (1893).

Herbæ perennæ, hispidæ. *Flores* in racemis scorpioideis geminis nudis terminalibus dispositi. *Calyx* campanulatus vel tubulosus, quinque-partitus vel quinquedentatus. *Corolla* infundibuliformis vel subcylindrica, limbo ventricoso late breviterque quinquedentato, dentibus semiorbicularibus triangularibusve apice obtusis sæpissime breviter patentibus. *Fornices* quinque, lineares vel subulati, conniventes, margine papillosi, inclusi raro exserti, cum staminibus alternantes. *Stamina* inclusa, antheris oblongis. *Stylus* filiformis, breviter exsertus, stigmate minute capitato. *Nuculæ* quatuor, liberæ, ovatæ, magis minusve curvatæ, oblique carinatæ, area basilari annulari tumidâ excavatâ dentatâ toro insidente et eum cum dentibus amplectente; strophiolo oblongo pallido e cavitate pendente.

CHARACTERS OF THE SPECIES.

The *root* in the greater number of the species is fusiform, either simple or branched, and sometimes very thick and fleshy. In the remaining species it is more or less creeping, with nodular, tubercular or cylindrical thickenings, being simple or branched according to the species.

The *stem* is correlated with the root—in the species with a fusiform root it is branched, constituting the *Ramosa*, and in those with a creeping root it is normally simple—the *Simplicia*. In the *Ramosa* the branches may be simple, bearing only one pair of leaves and racemes, or compound and similar to the main stem. Again, the branches may be much smaller than the stem and arranged in a racemose manner, or the stem may be subdichotomous, with the branches approaching it in size. In the *Simplicia* the stem is often bifid at the apex, and sometimes bears rudimentary branches in the axils of the leaves, or more rarely fully developed flowering branches.

The clothing of the stem and branches generally consists of a fine, scattered pubescence, together with longer hairs which may be slender and soft, setose and rigid, or claw-like and prickly, with or without tubercular bases. In the inflorescence the clothing is denser than that of the stem, and often consists of curved or uncinate hairs directed upwards.

The *leaves* are sometimes bullate, and are entire or very occasionally partially dentate, but this is probably an abnormal condition. The margin, however, is often repand-sinuate and minutely eroso-denticulate. In outline they vary from subrotund to oblong, ovate, or narrowly lanceolate, with the base cordate or rounded, suddenly contracted or gradually attenuated. The blade of the leaf is more or less decurrent on the petiole, on each side of which it forms a membranous margin, and when the leaves are sessile it sometimes forms wings or decurrent lines on the stem. The relative length and breadth of the leaves may vary considerably in the same species, and the autumnal leaves are often very large in comparison with those of the flowering season. The clothing of the leaves, like that of the stem, is of two kinds, but the hairs are generally shorter, straighter and more regularly disposed than on the stem. On the upper surface the hairs are, in the dried state, appressed, all pointing towards the apex of the leaf, and are often borne on tubercular bases, especially on the older leaves. The lower surface is more softly hairy with longer hairs, but often bears tubercular setæ on the midrib and veins.

The *inflorescence* consists of a pair of scorpioid racemes each with a leaf at the base, and the flowers are arranged in two rows on the upper side of the rhachis. In the *Ramosa* the flowers are generally more numerous and more shortly pedicelled than in the *Simplicia*, and consequently form denser racemes.

The *calyx* furnishes a good character for the division of the *Ramosa* in the relative length of its segments or teeth, which are sometimes longer and sometimes shorter than the tube. These vary from triangular or lanceolate to linear, with the apex acute or obtuse, and are of importance in the discrimination of many of the species. The margins of the segments are ciliate, in the *Simplicia* often conspicuously so, because the back of the segments is puberulous and almost destitute of long hairs. In fruit the calyx is more or less accrescent and becomes strongly hispid or setose, with the segments at first connivent over the nutlets; but when the fruit is abortive the segments are widely spreading. (See note on *S. patens*, Sibth.)

The *corolla* when well developed is infundibuliform or subcylindrical, with a more or less ventricose limb which is generally equal in length to the tube, but occasionally falls short of it. The margin is divided into five broadly ovate or triangular teeth with a short, obtuse, spreading apiculus. Owing to unfavourable conditions of growth the corolla is sometimes narrowly clavate with the mouth unexpanded and the teeth narrow, acute and erect. It is needless to say that flowers in this condition should not be taken as characteristic of the species.

The *corolla-scales* alternate with the stamens and spring from the top of the corolla-tube a little above the insertion of the latter, their point of attachment being marked by a depression on the outside of the corolla. They vary from linear-oblong to subulate, with the tip obtuse or acute, and in relative length they vary from a little shorter than the stamens to more than double their length. They sometimes show a tendency to become furcate at the apex. The margin bears several rows of papillate cells which, in the unexpanded flower, interlace with those of the contiguous scales and so form a cone closing the throat of the corolla.

The *stamens* are included, the anthers oblong with the cells either obtuse or apiculate at one or both ends. The relative length of the anther and filament is sometimes a good specific character, and it is customary to estimate this, not from the entire length of the filament, but from that part which is not concealed by the anther.

The *style* is filiform with a minute capitate stigma, and in the mature flower is shortly exserted. It is sometimes bent about one millimetre below the stigma, and this has been given as a specific character of *S. peregrinum*, in which it is frequently but not invariably present. This peculiarity sometimes occurs in other species, and appears to be caused by the elongation of the style while the flower-bud is still tightly closed.

The *nutlets* are ovate or oblong, more or less curved, in two pairs, with the contiguous sides of each pair slightly flattened so that the nutlet is obliquely keeled. The surface is more or less distinctly marked with a few large facets or areolæ and is smooth and shining or granulated and opaque. The base is annular and tumid, and furnished with teeth which clasp the torus while the nutlet is still attached, but are generally inflexed in the dried state. The strophiole is white, oblong and protrudes through the excavated base of the nutlet. In certain species some plants produce abundance of fruit while others are completely sterile. In one species, *S. floribundum*, Shuttlw., the fruit appears to be always undeveloped.

All the species flower in the spring and early summer, but in some cases they continue flowering throughout the summer and autumn.

Classification of the Species.

In De Candolle's 'Prodromus,' the first work in which all the known species of *Symphytum* were brought together, no attempt was made to divide the genus into groups or to classify the species.

The first author to do this was Boissier, whose arrangement in the 'Flora Orientalis' is given below.

I. Corolla-scales included.
  1. Root fusiform or branched: *S. officinale*, Linn., *orientale*, Linn., *caucasicum*, Bieb., *tauricum*, Willd., *sylvaticum*, Boiss., *anatolicum*, Boiss., *brachycalyx*, Boiss., *palæstinum*, Boiss., *kurdicum*, Boiss. & Hausskn., *asperrimum*, Bieb., *sepulcrale* Boiss. & Bal.
  2. Root tuberous: *S. tuberosum*, Linn., *grandiflorum*, DC.

II. Corolla-scales exserted: *S. bulbosum*, Schimp., *ottomanum*, Friv.

The next attempt to group the species was made by Otto Kunze (Pl. orient.-rossic. in Act. Hort. Petropol. x. 1887, p. 219). He reduces the number of species to five, and apparently regards all the others as synonymous with these. His "species" are :—

1. *S. bulbosum* including *S. ottomanum.*
2. *S. tuberosum* ,, *S. sylvaticum.*
3. *S. tauricum* ,, *S. grandiflorum.*
4. *S. officinale* ,, *S. uliginosum, caucasicum* and *mediterraneum.*
5. *S. orientale* ,, *S. peregrinum, asperum, palæstinum, kurdicum, anatolicum, brachycalyx, sepulcrale* and *grandiflorum,* hort. nec DC.

I altogether fail to see how any characters could justify such an incongruous grouping of the species as is here displayed.

The arrangement by Gürke in Engler & Prantl's 'Pflanzenfamilien' follows that of Boissier, but adds *S. cordatum,* Waldst. & Kit., to the group of *S. officinale.*

Finally, Kusnezow in the "Caucasian Species of the Genus *Symphytum*" (1910), retains Boissier's main divisions, but carries the subdivision of these a step further. The following is an outline of his system :—

I. Eusymphytum.
  i. Cyanea. A. *S. officinale, uliginosum, mediterraneum, molle, caucasicum.* B. *S. orientale, brachycalyx, palæstinum, kurdicum, anatolicum, sepulcrale, asperum, peregrinum.*
  ii. Ochroleuca. A. *S. tuberosum, Gussonei.* B. *S. cordatum, grandiflorum, tauricum, sylvaticum.*

II. Bulbosum. *S. bulbosum, ottomanum.*

The weak point in all these arrangements is that the main sections are founded on a comparatively unimportant character, viz., the relative length of the corolla-scales and the corolla. From this it results that *S. bulbosum* and *S. ottomanum,* in which the scales are longer than the corolla, are associated together, and each is separated from the species to which it is naturally allied. To the characters of the groups adopted by Kusnezow the same objection applies, with the further disadvantage that they are not sufficiently definite and admit of numerous exceptions, especially with regard to the branching of the stem and the colour of the flowers.

I now submit the system of classification which a study of actual specimens of all the known species (except the doubtful *S. sicyosmum*), many of them in the living state, has led me to adopt, and which has already been outlined when treating of the characters used in the determination of the species.

This study has convinced me that the genus is naturally divided into two sections, one containing the plants with a branched stem and fusiform root, and the other those with a simple stem and a more or less creeping and tuberous root. Of these sections the two British species of *Symphytum* are examples, the *Ramosa* being represented by *S. officinale*, and the *Simplicia* by *S. tuberosum*.

The *Ramosa* may be readily divided by the character of the calyx, as to whether its segments are longer or shorter than the calyx-tube. The groups thus formed may be subdivided by the leaves being decurrent or not, by the colour of the flowers, and by the corolla-scales being included or exserted.

By these means well defined sections are formed, in which the species are connected by important characters. There are some cases in which it is difficult to decide on the true relationship of the plant, but I believe that on the whole no species will be found to be far from its proper position in the arrangement I propose.

Conspectus of the Sections.

Division I. RAMOSA.

Subdivision i. Segmentata.

Section 1. **Officinalia.** *S. officinale*, Linn., *S. uliginosum*, Kern.

Section 2. **Cærulea.** *S. asperum*, Lepech., *S. peregrinum*, Ledeb., *S. sepulcrale*, Boiss. & Bal., *S. armeniacum*, Bucknall.

Section 3. **Albida.** *S. tauricum*, Willd., *S. sylvaticum*, Boiss., *S. anatolicum*, Boiss., *S. ottomanum*, Friv.

Subdivision ii. Dentata.

Section 4. **Orientalia.** *S. orientale*, Linn., *S. kurdicum*, Boiss. & Hausskn., *S. caucasicum*, Bieb., *S. floribundum*, Shuttlw., *S. pseudobulbosum*, Azn.

Section 5. **Suborientalia.** *S. palæstinum*, Boiss., *S. brachycalyx*, Boiss., *S. Bornmuelleri*, Bucknall.

Division II. SIMPLICIA.

Section 6. **Tuberosa.** *S. tuberosum*, Linn., *S. mediterraneum*, Koch, *S. Gussonei*, Schultz, *S. bulbosum*, Schimp., *S. Zeyheri*, Schimp.

Section 7. **Cordata.** *S. cordatum*, Waldst. & Kit., *S. grandiflorum*, DC.

KEY TO THE SPECIES.

	Stem branched; root fusiform or with fusiform branches; flowers generally numerous	1.
	Stem simple or nearly so; root more or less creeping with tuberous expansions; flowers generally few, yellowish	19.

Division I. RAMOSA.

1.	Calyx divided to or below the middle	2.
	Calyx not divided to the middle	12.
2.	Leaves decurrent on the stem from node to node, or only on the dilated and clasping petiole, but then the plant is glabrescent and scabrid; nutlets smooth.	3.
	Leaves not decurrent; nutlets generally granulated	5.

Subdivision i. SEGMENTATA.

Section 1. **Officinalia.**

3.	Plant more or less densely pilose-hispid; lower leaves ovate-lanceolate, upper oblong-lanceolate entirely decurrent; flowers white or yellowish (a. *ochroleucum*, DC.), or dull purple (b. *purpureum*, Pers.)	1. *S. officinale*, Linn.
	Plant thinly hispid, glabrescent or asperous with minute prickles and their tubercular bases; leaves narrowly lanceolate; corolla red-purple or violet	4.
4.	Upper leaves partially decurrent, subhispid; calyx puberulous	*S. officinale* var. *lanceolatum*, Weinm.
	Upper leaves not decurrent with dilated and clasping petioles, or partially decurrent (var. *pseudopterum*, Borb.), the lower narrow; plant glabrous except for small prickle-like hairs and their tubercular bases; calyx-segments ciliate with small prickles	2. *S. uliginosum*, Kern.
5.	Corolla blue or purple; plant often tall, stout	6.
	Corolla white, or, if blue, smaller; plant more slender.	9.

Section 2. **Cærulea.**

6.	Calyx large with acute segments; corolla rose-colour then clear blue; upper leaves sessile, uncinately adnexed to the stem	4. *S. peregrinum*, Ledeb.
	Calyx with obtuse segments	7.
7.	Calyx small; corolla blue, 3–4 times longer than the calyx; upper leaves subpetiolate	3. *S. asperum*, Lepech.
	Calyx large; corolla purple (or blue?), 2, rarely 4 times as long as the calyx	8.
8.	Leaves ovate with rounded base, the middle cauline petiolate; stem with long, slender hairs	5. *S. sepulcrale*, Boiss. & Bal.
	Leaves oblong-elliptic, the middle and upper cauline amplexicaul; stem with short, stout, claw-like prickles	6. *S. armeniacum*, Bucknall.

Section 3. **Albida.**

9. Corolla-scales exserted .... 10. *S. ottomanum*, Friv.
Corolla-scales included .... 10.
10. Lower leaves cordate; corolla-scales obtuse; nutlets granulated .... 7. *S. tauricum*, Willd.
Lower leaves not cordate .... 11.
11. Calyx-segments linear, obtuse; raceme 5–7-flowered; nutlets smooth or very minutely granulated, shining; flowers white .... 8. *S. sylvaticum*, Boiss.
Calyx-segments lanceolate, acute or subacute; raceme many-flowered; nutlets granulated; corolla small, white or violet; stem dichotomously branched nearly from the base .... 9. *S. anatolicum*, Boiss.

Section 4. **Orientalia.**

12. Corolla-scales slightly exserted; stem tall, robust, with erect-spreading branches, narrowly winged below .. 15. *S. pseudobulbosum*, Azn.
Corolla-scales included .... 13.
13. Flowers blue; lower leaves gradually attenuated into the petiole .... 11. *S. caucasicum*, Bieb.
Flowers white or yellowish .... 14.
14. Upper leaves decurrent; flowers numerous, shortly pedicelled; calyx campanulate .... 14. *S. floribundum*, Shuttlw.
Upper leaves not decurrent; calyx more or less cylindrical .... 15.
15. Plant attaining 5 or 6 dcm., fairly stout; leaves broadly ovate with a subcordate truncate or rounded base; petiole margined at the apex; nutlets curved .... 16.
Plant scarcely exceeding 4 dcm., more slender, generally with long slender branches; petioles margined to the base; nutlets nearly straight .... 17.
16. Upper leaves sessile; plant closely and softly pubescent; calyx divided to scarcely more than $\frac{1}{4}$ into oblong subobtuse teeth .... 12. *S. orientale*, Linn.
Upper leaves petiolate; plant tubercular-setose, asperous; calyx divided to $\frac{1}{3}$ or $\frac{1}{2}$ into lanceolate, subobtuse teeth .... 13. *S. kurdicum*, Boiss.

Section 5. **Suborientalia.**

17. Calyx cylindrical, divided to $\frac{1}{6}$ into broad, obtuse teeth, accrescent in fruit; plant racemosely branched; leaves oblong with subcordate, rounded or subcuneate base. 18. *S. Bornmuelleri*, Bucknall.
Calyx divided to $\frac{1}{4}$ or $\frac{1}{3}$ into linear or triangular teeth; plant dichotomously branched .... 18.
18. Calyx very accrescent in fruit, broadly cylindrical, with obtuse teeth; lower leaves with subcordate, rounded or attenuate base, 3–6 cm. long, or (var. *majus*, Bucknall) 17 cm. long, with entire or (var. *dentatum*, Boiss.) acutely dentate margin .... 16. *S. palæstinum*, Boiss.

	Calyx scarcely accrescent in fruit, shortly campanulate with acute or subacute teeth; lower leaves gradually attenuate into the broad petiole	17. *S. brachycalyx*, Boiss.

Division II. SIMPLICIA.

19.	Root thick and tuberous or slender and bearing tubercles; leaves attenuate at the base or the lowest subcordate or rounded	20.
	Root with cylindric thickenings; leaves broadly ovate, cordate, rarely only rounded at the base	25.
20.	Corolla-scales included	21.
	Corolla-scales exserted	24.

Section 6. **Tuberosa.**

21.	Lower leaves nearly as large as the middle stem-leaves; stem with short internodes	20. *S. mediterraneum*, Koch.
	Lower leaves much smaller than the middle stem-leaves; stem taller with longer internodes	22.
22.	Root slender with tubercles at intervals, simple	21. *S. Gussonei*, Schultz.
	Root thick, tuberous, branched	23.
23.	Leaves ovate-lanceolate or elliptic, 2–3 times as long as broad	19. *S. tuberosum*, Linn.
	Leaves linear-lanceolate, about 5 times as long as broad; calyx-segments very narrowly subulate	*S. tuberosum*, Linn. var. *angustifolium*, Kern.
24.	Lower leaves smaller than the middle stem-leaves; stem sometimes branched above, or with rudimentary branches in the upper axils	22. *S. bulbosum*, Schimp.
	Lower leaves nearly as large as the middle stem-leaves, broadly ovate, often cordate or rounded at the base; stem sometimes branched below or with rudimentary branches in the lower axils	23. *S. Zeyheri*, Schimp.

Section 7. **Cordata.**

25.	Leaves large, sub-rotund, deeply cordate, nearly glabrous; barren shoots erect	24. *S. cordatum*, Waldst. & Kit.
	Leaves smaller, cordate or rounded at the base, asperous with short stiff hairs; barren shoots decumbent	25. *S. grandiflorum*, DC.

1. S. OFFICINALE, *Linn., Sp. Pl.* ed. I. p. 136 (1753).

Radix crassa, carnosa, fusiformis, ramosa. *Caulis* pilis longis conicis albis deflexis vestitus, ramosus, laminâ foliorum decurrente alatus. *Folia* parce pilosa, raro tuberculato-setosa, radicalia et inferiora ovato-lanceolata in petiolum cuneatim contracta, superiora oblongo-lanceolata, a basi latâ decurrentia. *Rachis* pedicelli calyxque pilis mollibus conicis deorsum leviter curvatis dense vestiti. *Calyx* infra tertiam partem inferiorem in lacinias lanceolato-subulatas acuminatas pilosas fissus. *Corolla* albida,

ochroleuca, purpurea vel rosea, calyce duplo longior. *Fornices* triangulari-subulati, stamina vix superantes. *Antheræ* filamentis duplo longiores. *Nuculæ* læves vel leviter areolatæ, nitidæ, nigræ, supra basin non constrictæ.

Caulis 3–12 dcm. altus; folia radicalia 15–25 cm. longa, 6–8 cm. lata; caulina 15–20 cm. longa, 4–5 cm. lata, summa 4–6 cm. longa, 1–1·5 cm. lata; flores 14–18 mm. longi; calyx 7–8 mm. longus; corolla 15–17 mm. longa; nuculæ 4·4 mm. longæ, 2·5 mm. latæ.

Symphytum herbarii vocant Consolidam majorem vulgus Comfrey, W. Turner, Libellus (1538).

Consolida major, Lobel, Stirp. Hist. p. 315 (with figure) (1576); C. Bauhin, Phytopinax, p. 500 (1576).

Symphytum magnum, Lyte, A niewe Herball, p. 145 (1578).

Symphytum Alum seu Alus, Lobel, Stirp. Advers. pars ii. p. 251 (1605).

Symphytum magnum, J. Bauhin, Hist. iii. p. 593 (1650); Ray, Synopsis, ed. 1, p. 77 (1690).

S. officinale, Linn., Hudson, Fl. Angl. ed. 1, p. 68 (1762); Withering, Bot. Arr. ed. 1, p. 105 (1776).

S. bohemicum, Schmidt, Böh. cent. iii. p. 13 (1794).

S. officinale, β. purpureum, Guss, Fl. Sic. Prod. i. p. 219 (1827); DC. Prod. x. p. 37 (1846); Ledeb. Fl. Ross. iii. p. 114 (1846–51); Gren. & Godr. Fl. Fr. ii. p. 551 (1850); Willk. & Lange, Prod. Fl. Hisp. ii. p. 491 (1870).

S. molle, Janka in Termés. Füzetek, i. p. 29 (1877).

S. officinale, Linn., Rouy & Fouc. Fl. Fr. x. p. 289 (1908); Coste, Fl. Fr. ii. p. 581 (1903); Kusnez. Cauc. Sp. Symph. pp. 22 & 65, t. i. figs. 1 & 5 (1910).

GEOGR. DISTR.—From BRITAIN and SPAIN to RUSSIA and SIBERIA; and from SCANDINAVIA to S. ITALY, GREECE and TURKEY.

Subvar. α. OCHROLEUCUM, *DC.* Flores albidi vel ochroleuci.

Consolida major flore albo, Gerard, Herb. p. 660 (1597).

S. officinale, Linn., Oeder, Fl. Dan. t. 664 (1777); Curt. Fl. Lond. ed. 1, vol. ii. t. 230 (1777); Smith, Eng. Bot. xii. t. 817 (1801); DC. Prod. x. p. 37 (1846); Syme, Eng. Bot. t. 1515 (1867).

Subvar. β. PURPUREUM, *Pers.* Flores purpurei.

Consolida major flore purpureo, Gerard, l. c.

S. patens, Sibth. Fl. Oxon. p. 70 (1794).

S. officinale β. purpureum, Persoon, Synopsis, i. p. 161 (1805).

S. officinale var. *bohemicum*, D. Don, Brit. Fl. Gard. ser. ii. vol. iv. t. 304 (1838).

S. officinale β. purpureum, Pers., DC. Prod. x. p. 37 (1846).

Specimens examined:—Britain. S. magnum. Palace Garden, Bangor. "With bright red flowers," Dr. Foulkes. *Herb. Univ. Cantab.*—S. consolida major flore purpureo. Chelsea Garden, 1752. *Herb. Mus. Brit.*—S. officinale, L. Edinburgh Garden. *Herb. Smith* in *Herb. Soc. Linn.*—S. officinale β. patens. Warrington, Lancs. W. Wilson, 1824. *Herb. Univ. Cantab.*—S. rugosum. "Lee's Garden," 1827. *Herb. Kew.*—S. officinale β. purpureum. Bentley, Hants. C. M. Lemann, 1827. *Herb. Univ. Cantab.*—S. officinale β. patens. Bath. C. C. Babington, 1839 & 1853. *Herb. Univ. Cantab.*—S. officinale β. patens. Pangbourne, Berks. C. C. Babington, 1847. *Herb. Univ. Cantab.*—S. pictum. Herb. Thomas Moore, Chelsea. *Herb. Kew.*—S. patens, Sibth. Oxford Bot. Gard., Baxter. W. Thiselton Dyer, 1867. *Herb. Kew.*—S. officinale, Linn. Killiecrankie, 1874. *Herb. G. C. Druce.*—S. officinale β. patens. Wellington, Salop. F. R. Tennant, 1881. *Herb. Univ. Cantab.*—S. tuberosum, Linn. Settle, Yorks. W. H. Painter, 1888. *Herb. Bicknell.*—S. officinale v. patens. R. Esk, Midlothian. F. C. Crawford, 1890. *Herb. J. W. White* and *C. E. Salmon.*—S. officinale, Linn. Staplefield, Sussex, 1891. *Herb. Bicknell.*—S. officinale β. purpureum. Kington, Berks., 1893. *Herb. G. C. Druce.*—S. officinale α. ochroleucum. Windermere. R. F. Tennant, 1894. *Herb. Univ. Cantab.*—S. officinale β. patens. Ealing. A. L., 1899. *Herb. G. C. Druce.*—Craigcrook, Edinburgh. F. C. Crawford, 1900. *Herb. C. E. Salmon.*—S. officinale α. ochroleucum. Shepperton, Middlesex, 1900. *Herb. Kew.*—Rosyth Castle, Fife. F. C. Crawford, 1900. *Herb. C. E. Salmon.*—S. officinale β. patens. Flitwick, Beds., 1903. *Herb. G. C. Druce.*—Also from the counties of Cornwall, Devon, Somerset, Surrey, Dorset, Hants (Isle of Wight), Kent, Surrey, Essex, Bucks, Norfolk, Hereford, Gloucester, Stafford, Brecon, Lincoln, Derby, York, Kirkcudbright, Roxburgh, Wicklow, Waterford.

The Continent.—S. officinale, Linn. *Herb. Linn.* in *Herb. Soc. Linn.*—S. caucasicum, Bieb., "sed calyx profundius fissus" (β. purpureum). *Herb. Besser* in *Herb. Kew.*—S. asperrimum, Bieb. (β. purpureum). *Herb. Besser* in *Herb. Kew.*—S. consolida. *Herb. Pallas* in *Herb. Mus. Brit.*—S. officinale, var. β. Burgdorf, Cant. Berne. L. Leresche, 1831. *Herb. Univ. Cantab.*—S. sp. "Fl. atropurpureus." Schandau, Saxony, 1836. *Herb. Kew.*—S. officinale, Linn. Bedford, U.S.A. Leg. Girard, 1847 (Introduced). *Herb. Mus. Brit.*—S. officinale latifolium. Varberg, Sweden. E. Fries. *Herb. Kew.*—S. officinale, "Fl. ruber." Carinthia. Reuter, 1857. *Herb. Cons. Bot. Genev.*—S. officinale var. purpurea. Upsala, "in cultis rarius." F. Ahlberg, 1865. *Herb. Mus. Brit.*—S. tauricum. Jardin du Crest, Jussy, Geneva, 1869. *Herb. Cons. Bot. Genev.*—S. officinale, Linn. Ribières, Hautes Alpes. Reverchon, 1873. *Herb. Bailey* and *S. Lond. Bot. Inst.*—S. officinale α. ochroleucum. Lausanne, 1875. *Herb. Kew.*—S. molle, Janka. Hatvan, Hungary. F. Bohatsch, 1878 & 1885. *Herb. Kew.*, *Bailey*, and *S. Lond.*

Bot. Inst.—S. officinale, Linn. Samthal, Botzen. C. Packe, 1878. *Herb. Univ. Cantab.*—Vallis S. Ledro, S. Tyrol. Porta, 1878. *Herb. Bailey* and *S. Lond. Bot. Inst.*—Englefeld, Pest. Steinitz, 1880. *S. Lond. Bot. Inst.*—Lund, Sweden. Carl Paulsen, 1885. *Herb. J. W. White.*—Feldkirch, Austria? 1886. *Herb. Bailey* and *S. Lond. Bot. Inst.*—S. patens. Stockholm. Dr. Andersen, 1887. *Herb. Kew.*—S. officinale variatio vernalis & autumnalis f. latifolia (β. purpureum). Perpignan. Debeaux, 1879. *Herb. Kew.*—S. officinale, Linn. Robilante, Italy, 1888. *Herb. Bicknell.*—Novogrodek, Russia. W. Dybowski, 1893. *Herb. Kew.*—S. Béat, Haute Garonne. Bordère. *Herb. Bicknell.*—Veynes, Hautes Alpes, 1905. *Herb. Bicknell.*—Rubano, Padua. A. Béguinot, 1907. *Herb. Bicknell.*

Without date:—S. officinale, Linn. U.S.A. Leg. Rafinesque (Introduced). *Herb. Delessert* in *Herb. Cons. Bot. Genev.*—S. grandiflorum, DC. Jard. Bot. Genev. *Herb. Cons. Bot. Genev.*—S. officinale v. calycinum. Scandinavia. *Herb. Bailey.*—S. officinale. Moldavia. Guebhard. *Herb. Cons. Bot. Genev.*—S. uliginosum, Kern. R. Rakos, Pest. *Herb. Bailey.*—S. officinale v. bohemicum. Pforta, Thuringia. *Herb. Bailey.*—Transylvania. *Herb. Kew.*

Var. LANCEOLATUM, *Weinm. in Bull. Soc. Imp. Nat. Mosc.* No. vii. p. 57 (1837).—*Caulis* inferne glaberrimus, basi violaceus, plus minus hispidus. *Folia* inferiora longe petiolata, plus minus anguste lanceolata, in petiolo decurrentia, superiora sessilia, summa paullo decurrentia, omnia glabra vel subhispido-pilosa, præcipue ad venis. *Calycis* laciniæ ovatæ, oblongæ, acuminatæ adpressæ, tubo corollæ breviores, præcipue margine et in dorso hispidæ. *Corolla* cylindraceo-campanulata, granulis albis obsita, ore contracta, purpureo-violacea. *Fornices* lanceolati, corolla parum breviores. Caulis 6–9 dcm. altus.

Conf. *S. tanaicense*, Steven, Obs. Asperif. Taur.-Cauc. p. 577 (1851).

GEOGR. DISTR.—RUSSIA: Bessarabia to the Crimea, the Caucasus, and the Ural.

SPECIMENS EXAMINED:—*Native.* S. asperrimum. Crimea. M. Beaupré, 1816. *Herb. DC.*—S. officinale γ (Alph. DC.), "versus Caucasum, Revilliod, 1821. *Herb. DC.*—S. lanceolatum. Bessarabia. Tardent, 1822. *Herb. DC.*—S. officinale v. purpureum. Sarepta, islands in the Volga, 1872. *Herb. Mus. Brit.*

Introduced or cultivated.—S. patens, Sibth. Toxteth Park, Liverpool. H. Sheppard, 1867. *Herb. Hookerianum* in *Herb. Kew.*—Sevenoaks. *Cult.* Mr. E. M. Holmes, 1911.

In typical *S. officinale* the decurrent blade of the leaves forms wings with nearly parallel margins, which extend from node to node on the stem and branches.

In the variety *lanceolatum* and in other species in which the leaves are decurrent, the wings are cuneate, and end in an acute point between the nodes. A distinctive appearance is given to this species by the uppermost leaves, which are supported in a nearly erect position by their broad decurrent base, and generally overtop the flowers.

The subvarieties *α. ochroleucum* and *β. purpureum* only differ from each other in the colour of the flowers, and intermediate forms, in which the flowers are striped with dusky purple and yellowish or greenish white, are common. Pale red and orange tints also occur, but these seem to be due to abnormal conditions.

So far as my experience goes a blue tint in the flowers is the result of hybridity with *S. peregrinum*, Ledeb.

S. officinale is usually fairly hairy and often densely so above, but forms are found, especially in Eastern Europe, in which the plant loses much of its hairiness and becomes asperous with thinly scattered tubercular setæ. When this is the case and the leaves are also narrowly lanceolate and only partially decurrent, the plant belongs to the variety *lanceolatum*, Weinm., which no doubt consists of a series of forms intermediate between typical *S. officinale* and the very distinct *S. uliginosum*, Kerner. *S. tanaicense*, Steven, which was gathered in the region of the river Don (Tanais) in 1817 was described in 1851 as follows:—"Foliis lanceolatis longe petiolatis, superioribus vix decurrentibus, cauleque glabriusculis, calyce ultra medium 5-partito, laciniis lanceolato-linearibus, acuminatis margine ciliatis, corollæ laciniis brevibus demum reflexis, nuculis lævibus non striatis. A *S. officinale* foliis vix decurrentibus et glabritie bene distinctum. Flores cæruleo-violacei." It is clear that this is either one of the above-mentioned intermediate forms, or *S. uliginosum* itself. That the latter is found in S. Russia is proved by an excellent specimen in the Fielding herbarium gathered at Novgorod-Sieversk in 1824 as *S. officinale*, of which there is also a typical specimen on the same sheet. It is therefore quite possible that *S. uliginosum* is identical with *S. tanaicense*, but as I have seen no authentic specimen of the latter this must remain doubtful.

The colour of the flowers in these plants is described as purple or blue-violet, but in dried specimens the colour appears to be the same as in a plant cultivated at Sevenoaks by Mr. E. M. Holmes, and in this the flowers are rose-purple. At first I referred this plant to *S. uliginosum*, but now consider that it is better placed with *S. officinale* v. *lanceolatum*.

S. molle, Janka, is described as a small plant, glabrous below and softly hairy above, simple or slightly branched, with decurrent glabrescent upper leaves and white flowers.

None of the specimens so named which I have seen agree with this description, but are densely hairy forms of *S. officinale*.

The description of *S. patens*, Sibth., is as follows:—"Foliis ovato-lanceolatis decurrentibus, calyce patente tubo corollæ breviore, the red-flowered Comfrey." Smith in 'English Botany,' vol. xii. in the notes accompanying t. 817, remarks:—"Dr. Sibthorp has made a new species of the red or purple-flowered variety, distinguishing it by a shorter and spreading calyx, which we and several of our friends have failed to discover." As will be seen by the list of synonyms and specimens, Sibthorp's name has often been given, both in Britain and on the Continent, not only to the purple-flowered *S. officinale*, but also to *S. peregrinum* and its hybrids, and even to *S. asperum*, Lepech., but no one has been able to recognise the "spreading calyx" described by him. A possible explanation of this is that in sterile plants, which are of frequent occurrence, the calyx is wide open after the corolla has fallen, and exposes the abortive nutlets, and Sibthorp may have founded his *S. patens* on plants in this condition.

The specimen named *S. officinale* in Linnæus's herbarium is, according to C. Hartmann in Annotat. de plant. Scand. herb. Linn. (K. Sv. Vet.-Ak. Handl. 1849–51), p. 50, not that species, but *S. orientale*, Fr. (*S. uplandicum*, Nym.). Having carefully examined the plant in question, I cannot accept this determination for the following reasons:—the stem shows fragments of a broad wing, and the leaves on a small branch are completely decurrent; the upper leaves are narrowly lanceolate and erect, and the calyx is closely hispid like that of *S. officinale*. Moreover, I have found no evidence that either *S. peregrinum* or *S. asperum*, which were included in Fries's *S. orientale*, were cultivated in Western Europe until the beginning of the last century, and it is unlikely that Linnæus had ever seen these species. In my opinion, therefore, the plant is *S. officinale*. As a plant at Kew from Besser's herbarium named *S. asperrimum* is evidently not that species, the names of *S. peregrinum* and *S. Donii* have been suggested for it; but the stem is narrowly winged, the upper leaves are erect, and the inflorescence is densely hairy as in *S. officinale*. The same names are suggested for another of Besser's plants labelled "S. caucasicum," and in another hand "sed calyx profundum fissus." This is nearly the same as the last but not so densely hairy, and I have little doubt but that both these specimens must be referred to *S. officinale*.

A plant in the De Candolle herbarium labelled "An echinatum Ledeb.? Ex Reut." is like *S. officinale* except that it is subglabrous and scabrid with tubercles like *S. uliginosum*. A. De Candolle has written on the sheet "S. lanceolatum, DC. MS. Mon père l'avait rapporté a *S. officinale* lanceolatum *β* Weinm. dont il faisait une espèce en le reunissant à la fig. de Don. Brit. flow. gard. t. 294, mais cette fig. représente des appendices de la corolle tout différents. L'échantillon actuel parait s'entrer dans le *S. officinale* *γ* mais les anthères sont égales aux appendices." Don's figure 294 represents *S. caucasicum*, so that the reference to the corolla-scales may be disregarded, and the stamens in De Candolle's specimen, which are visible in a fragment of a flower, are like those of *S. officinale*. A lower stem-leaf measures 24 × 9·5 cm. I consider it to be a broad-leaved form of *S. lanceolatum*, and one of the series which connects *S. officinale* with *S. uliginosum*.

Here also may be placed a plant in Herb. Kew. labelled "*S. officinale β purpureum*, Pers. ex herb. hort. Petrop. Irbit, Rossia orient." It approaches *S. uliginosum* but has broadly oblong leaves, the middle broadly clasping and the upper decurrent.

2. S. ULIGINOSUM, *Kern. in Oestr. Bot. Zeitschr.* xiii. (1863) p. 227.

Radix fusiformis, ramosa. *Caulis* gracilis, ramosus, setis raris hamatis albidis tuberculatis adspersus. *Folia* setis minutis uncinatis deciduis tuberculatis exasperata, lanceolata, radicalia in petiolum longum, superiora in petiolum brevem subdilatatum amplexicaulem contracta, summa non vel plus minus decurrentia. *Calyx* in lacinias lanceolato-subulatas margine setis unguiformibus albis ciliatas et sæpe in dorso unica serie earundem munitas profunde fissus. *Corolla* violacea, calyce duplo triplove longior. *Fornices* anguste lanceolati, stamina æquantes. *Antheræ* filamentis subduplo longiores. *Nuculæ* curvatæ, supra basin non contractæ, obsolete areolatæ, læves vel minute rugulosæ, nitidæ, atræ.

Caulis 3–6 dcm. altus; folia radicalia 20–25 cm. longa, 7–10 cm. lata, superiora 5–10 cm. longa, 1·3–3·5 cm. lata; flores 14–17 mm. longi; calyx 7–8 mm., fructifer 14 mm. longus; corolla 12–14 mm. longa; nuculæ 4–5 mm. longæ.

Conf. *S. Vetteri*, Thellung in Beitr. zur Kennt. Schweiz. p. 460 (1907).

GEOGR. DISTR.—HUNGARY. S. RUSSIA.

SPECIMENS EXAMINED:—"S. vulgare," Gmelin. *Herb. Linn.* in *Herb. Soc. Linn.*—S. sp., *Herb. Smith* in *Herb. Soc. Linn.*—S. caucasicum-squarrosum. Caucasus, 1820. *Herb. W. H. Gower* in *Herb. Kew.*—S. officinale. Novgorod-Sieversk, 1824. *Herb. Fielding.*—S. uliginosum, Kern. Vesztö, Hungary. Borbás, 1877. *Herb. Kew., Mus. Brit., Fielding,* and *Univ. Cantab.*—S. uliginosum v. pseudopterum, Borb. Vesztö, Hungary, 1878. *Herb. Bailey.*—S. uliginosum, Kerner. Hungary (?). *Herb. Glennie Smith* in *Herb. Mus. Bristol.*—S. officinale, Linn. Sefton Park, Liverpool, 1874. *Herb. Bailey.*

The entire plant is glabrous except for small white deciduous prickles with tubercular bases, which render it scabrid and harsh to the touch. The calyx segments are long and gradually attenuated to an acute point, ciliate with small, strong, white prickles, and purplish in colour. The flowers appear to be rose-coloured. The nutlets are similar to those of *S. officinale*.

Kerner describes the leaves as not decurrent, but forms often occur in which the stem is partially winged, and this constitutes the variety *pseudopterum*, Borb.

A plant in the De Candolle Herbarium labelled "S. officinale var.? Ekaterinoslav ad Borysthemum (R. Dnieper), Herb. Besser," is quoted by De Candolle in the 'Prodromus.' The stem is very narrowly and partially winged, the leaves are lanceolate and tubercular-asperous, and the calyx is nearly glabrous with ciliate teeth. I can only refer it to *S. uliginosum.*

Mr. Bailey's herbarium contains five sheets of a plant gathered in Sefton Park, Liverpool, in 1874. They are indistinguishable from Hungarian specimens of *S. uliginosum*, and probably sprung from seeds introduced with grain or fodder. These are, so far as I know, the only examples of this species that have occurred in Britain.

3. S. ASPERUM, *Lepech. in Nov. Act. Acad. Sci. Petrop.* xiv. (1805) p. 442.

Radix crassa, ramosa. *Caulis* elatus, ramosus, setis validis uncinatis subretrorsis tuberculatis muricatus, sursum parce puberulus. *Folia* hispida vel tuberculato-setosa, ovata vel elliptica, acuminata, inferiora petiolata, basi cordata vel rotundata, summa subpetiolata, basi cuneata. *Rachis* pedicellique dense puberuli et pilis brevibus conicis rigidis asperi. *Calyx* parvus, setosus, ad tertiam partem inferiorem in lacinias lineari-oblongas obtusas fissus, fructifer parum accretus, tuberculato-setosus. *Corolla* primo rosea dein cærulea, calyce 4–5-plo longior. *Fornices* lanceolati, stamina subæquantes. *Antheræ* filamentis subæquilongæ. *Nuculæ* paullo curvatæ, supra basin constrictæ, valde venoso-areolatæ et tuberculatæ.

Caulis 9–18 dcm. altus; folia radicalia 15–19 cm. longa, 7–12 cm. lata, caulina 10–20 cm. longa, 4–10 cm. lata; flores 10–15 mm. longi; calyx 3–5 mm. longus; corolla 9–14 mm. longa; nuculæ 4 mm. longæ, 2·5 mm. latæ.

S. orientale folio subrotundo aspero flore cæruleo, Tournef. Cor. 7 (1703).

S. orientale, Linn. Sp. Pl. ed. I. p. 136 (1753) *p. p.*

S. asperrimum, Donn in Curt. Bot. Mag. t. 929 (1806); Bieb. Fl. Taur.-Cauc. i. p. 129 (1808).

S. echinatum, Ledeb. Ind. Sem. Hort. Dorp. supp. p. 5 (1811).

S. asperrimum, Roem. & Schultes, Syst. Veg. iv. p. 65 (1819).

S. patens, Fr. Fl. Suec. Mant. ii. p. 13 (1839) *p. p.*

S. orientale, Fr. Mant. iii. p. 18 (1842) *p. p.*

S. asperrimum, Biehler, Jacq. Eclog. pt. ii. p. 4, t. 118 (1844).

S. patens, Fr., Summ. Veg. Scand. p. 191 (1846) *p. p.*

S. asperrimum, Sims in DC. Prod. x. p. 38 (1846); Ledeb. Fl. Ross. iii. p. 115 (1846–51); Boiss. Fl. Orient. p. 175 (1879) *p. p.*; Aschers. & Gräb. Fl. Nordostd. Flachl. p. 577 (1898–99).

S. asperum, Lepech. ex Kusnez. Cauc. Sp. Gen. Symph. p. 35, t. i. figs. 3 & 7 (1910).

GEOGR. DISTR.—RUSSIA: Caucasus. PERSIA.

Specimens examined :—*Native.* Symphytum sp. "Cappadocia," Tournefort. *Herb. Mus. Brit.*—S. elatum. *Herb. Pallas* in *Herb. Mus. Brit.*—S. sp. Caucasus. Dr. Fischer, 1811. *Herb. Smith* in *Herb. Soc. Linn.*—S. sp. Caucasus. Steven, 1819. *Herb. DC.*—Caucasus. Steven, 1822. *Herb. Cons. Bot. Genev.*—S. caucasicum, Bieb. Caucasus. Wilhelms, 1826. *Herb. Fielding.*—S. asperrimum, Ledebour, 1838. *Herb. Kew.*—Stauropol, Caucasus. Godet, 1838. *Herb. DC.*—Gatgare et Kaischaur, Cauc. Iberic. R. F. Hohenacker, 1839. *Herb. Mus. Brit.*, *Univ. Cantab.*, and *Cons. Bot. Genev.*—S. asperrimum, Sims. Adjaria, Anticaucasus. Sommier et Levier, no. 954, 1890. *Herb. Barbey-Boiss.*—S. caucasicum, Bieb. Caucasus. St. G. Littledale, 1908. *Herb. Kew.*—S. asperrimum, Bieb. Persia. *Herb. Kew.*

Introduced or cultivated.—Britain : Symphytum sp. Hort. Kew. "Ex oriente," 1803. *Herb. Mus. Brit.*—S. sp. Cobham Lodge, 1831. *Herb. Forbes Young* in *Herb. Kew.*—S. asperrimum, Bieb. Bath. C. C. Babington, 1833. *Herb. Kew.*—Bath. J. B. French. *Herb. Mus. Brit.* and *Bailey.*—Marlborough, Wilts. J. B. French.—S. asperrimum, Donn. Stirling. Gideon Thompson, 1838.—Bowden, Cheshire, 1862. *Herb. Bailey.*—Silverdale, Lancs. H. Barbey, 1864. *Herb. Bailey.*—Bath. T. B. Flower, 1868. *Herb. Kew.* and *Bailey.*—S. asperrimum, Bieb. Balmuto, Fife. Boswell, 1876 and 1879. *Herb. Mus. Brit.* and *Bailey.*—S. orientale, Linn. Lane End, Lake Lancashire. A. Ley, 1881. *Herb. Kew.* and *Bailey.*—S. asperum, Lepech. Buckland, Devon. E. S. Marshall, 1894. *Herb. Kew.* and *Bailey.*—Fairford, Glos. H. J. Riddelsdell, 1908. *Herb. G. C. Druce.*—Cambridge Bot. Gard. R. I. Lynch, 1912.

Continent : S. orientale, Linn. Upsala. Th. M. Fries, 1852. *Herb. Kew.*—S. uplandicum, Nym. (S. patens, Fr.). Bergielund near Stockholm. Kleen, 1867. Schultz, Herb. Norm. ser. 2, no. 557. *Herb. Bailey, Bicknell,* and *Cons. Bot. Genev.*—S. asperum, Lepech. Hunne Berg, Vestergötland. H. Svenonius, 1893–4. *Herb. Bicknell.*—Venersborg, Dalsland. O. Lindholm, 1895. *Herb. Bailey.*—S. asperrimum, Bieb. Gorinka (Moscow). *Herb. Roemer* in *Herb. Mus. Brit.*—Jardin de Paris, 1821. *Herb. DC.*—Hort. Bot. Paris, 1835. *Herb. Cons. Bot. Genev.*—Chougny, Moïse. E. Moricand. *Herb. Cons. Bot. Genev.*—S. tuberosum, Jard. Bot. Amiens, 1864. *Herb. C. Bélanger* in *Herb. Cons. Bot. Genev.*—S. anatolicum, Boiss. Ins. Chios, Graec. Charrel, 1891 (Introduced ?). *Herb. Bailey.*—S. asperrimum, Bieb. Hort. Genev. 1905. *Herb. Cons. Bot. Genev.*

Linnæus united the two (or more) species discovered by Tournefort during his travels in the East, under the name of *S. orientale,* which he described as follows :—"Orientale 3. Symphytum foliis ovatis subpetiolatis. S. orientale folio subrotundo aspero flore cæruleo. Tournef. Cor. 7.

"S. constantinopolitanum, boraginis folio et facie, flore albo. Tournef. Cor. 7. Buxbaum cent. 5, p. 36, t. 68. Habitat juxta Constantinopol. rivulos primo vere."

As stated on p. 493, it is clear that *S. asperum*, Lepech., must be included, with one or more other species, in Tournefort's blue-flowered plant, and that his white-flowered plant is the one now known as *S. orientale,* Linn. Lepechin's description of *S. asperum*, written about 1798 and published in 1805, may be of interest. "Symphiti asperi nova species descripta ab Joanne Lepechin.—Radix perennis valde difformis magno volumine constans in varios lobos sulcis divisa, undique fibrillas nigricantes sat tenues incurvatas emittens. His ex lobis surgunt caules plures, altitudine 3–4 pedum fere æquantes, angulato-teretes ramosi sparsis spinulis hamatis obsiti. Folia inferiora cordata magna acuminata, fere sessilia, in medio costa elevata percursa, ex qua per latera disci foliorum exeunt rami apicibus suis continuis surculis divisi colore albidiore plaga superiori intensa, inferiori vero dilute viridia, punctis albidis aspersa. Folia superiora opposita, petiolata, pedunculis brevibus semidecurrentibus ; cætera ut in foliis majoribus. Flores racemosi pedunculati cœrulei, quorum figura, structura partium genitalium, fructus, reliquia ut in Symphito officinali. Huic planta nostra definiri potest ut sic S. caule hamato-aspero, foliis infer. cordato-lanceolatis sessilibus, superioribus oppositis. Hab. in jugo montium Caucas. Rossici." Lepechin's figure represents about 18 in. of the upper part of the stem. The leaves are ovate-acute, the largest about 12 × 5 cm., but only cauline leaves with branches in their axils are figured. The calyx is small with subobtuse segments.

In the figure of *S. asperrimum*, Donn, in Bot. Mag. 929, the shortly petioled stem-leaf is broadly ovate acuminate, and the highest leaves are elliptic-lanceolate and subpetiolate, the flowers are large, red then blue, and the calyx small with subobtuse segments. It is said to grow to a height of 5 ft., and the stem to be covered with small curved prickles.

Marschall von Bieberstein adopts the name of *S. asperrimum*, with *S. asperum*, Lepech., as a synonym. He had seen specimens "ex Iberiâ" (province of Tiflis), in Tournefort's herbarium, and states that it is frequent in the whole of the Caucasus on the margins of streams ; that it is sometimes of the height of a man and much branched ; that the leaves vary in breadth and the flowers are blue.

Ledebour in 1811 gives a brief, incomplete description of a plant which he calls *S. echinatum*, but later, in the 'Flora Rossica,' he says that this appears to be a variety of *S. asperrimum* with shorter, less deeply divided calyx.

In the same work Ledebour gives a more extended description of the plant as *S. asperrimum*, Sims, and for the first time describes the calyx-segments as "linear, obtuse,"—an important distinction between this species and *S. peregrinum*.

De Candolle in the 'Prodromus' still retains the name of *S. asperrimum*, Sims, with *S. asperum*, Lepech., as a synonym. He describes the leaves as "ovate-lanceolate, acute at each end," the corolla as "cœruleo-purpureo, four times longer than the calyx, which has subulate segments." This latter character, however, would apply better to *S. peregrinum*, Ledeb.

Finally Kusnezow, in his work on the Caucasian species of *Symphytum*, gives an excellent description of the plant as *S. asperum*, Lepech.

I have thought well to give at length the history of this plant on account of the confusion which has long existed between it and *S. peregrinum*, Ledeb., as well as some other species from which it is more easily distinguished. From *S. peregrinum* it differs in the generally more asperous clothing of the stem and inflorescence, the subpetiolate upper leaves with cuneate base, the blade of which is not adnexed to the stem, and especially in the small calyx with obtuse segments.

This species does not appear to produce good fruit very freely. The only nutlet which I have been able to examine was immature. It is strongly veined and reticulate, less curved and narrower than in *S. peregrinum*, and in these characters it agrees with Kusnezow's figure. From *S. sepulcrale*, *S. asperum* differs in the asperous clothing and in the smaller calyx, and from *S. armeniacum* in the petiolate cauline leaves and the small calyx.

As regards the leaves, there are two extreme forms. One of these has broadly ovate leaves as in Lepechin's and Donn's figures. In the other form the leaves are as described by De Candolle, "ovate-lanceolate, acute at each end." They are also smaller, eroso-denticulate, numerous on the long, slender branches, only decreasing gradually in size, and, as stated by Ascherson and Gräbner, "rather delicate, elongated-ovate." Whether these are permanent forms or only the result of different conditions of growth can only be decided by the observation and study of living plants.

I do not consider that, under the circumstances, any useful purpose would be served by giving varietal names to these forms. This will also apply to the variability of the clothing of the stem and inflorescence, which is more or less dense, as I believe, according to circumstances of soil and situation; when dense the setæ, though rigid and prickly, are slender, nearly straight and with small tubercular bases, but when few and scattered they are strong, uncinate and with large tubercular bases. The following notes on the specimens which have come under my notice will illustrate these points.

Tournefort's plant in Herb. Mus. Brit. has narrow leaves and is strongly tubercular-asperous. This is marked on the back of the sheet "Cappadocia," but Bieberstein states that he had seen a specimen in Tournefort's herbarium "Ex Iberiâ." As Iberia is within the area of *S. asperum* and Cappadocia is some distance from it, it is probable either that the latter name was understood to embrace a larger tract of country than is shown in the maps, or that there was an error as to the locality.

The specimen in Smith's herbarium is still more strongly tubercular-setose; there is no mention of its origin. Ledebour's specimen, *S. asperrimum*, Bieb., in Herb. Kew., has a large stem-leaf measuring 20 × 10 cm., and the upper ones are unusually broad. A plant "ex herb. hort. Petropolitani" is more softly hispid, and has large flowers. Transplantation to a garden may account for the weaker clothing. Th. M. Fries's *S. orientale* from Upsala has the calyx of *S. asperum*, but the leaves are large, thin, asperous and subdecurrent. The latter character is perhaps due to hybridization with *S. officinale*. To the same cause may be attributed the variation in the form and texture of the leaves of the Swedish plants, but it is difficult to account for the abnormal forms which occasionally occur even on this hypothesis, and it would require a careful study of the living plants to determine their real relations. That true *S. asperum* is found in Sweden is shown by a plant named *S. uplandicum*, Nym., from Bergielund (F. Schultz, Herb. Norm. ser. 2, no. 557), in which the stem, pedicels, and calyx are strongly tuberculato-setose, the leaves ovate-elliptic of moderate size, decreasing gradually upwards, the upper ones shortly petiolate, and the calyx-segments oblong and very obtuse. Plants named *S. asperum* from the Hunne Berg, Vestergötland, and Venersborg are similar.

As regards British specimens, reference has already been made to the figure, Bot. Mag. no. 929, which is a broad-leaved form. Gideon Thompson's plant from Stirling is similar. Babington's *S. asperrimum*, Bieb., was gathered by him in the Oakford Valley near Bath in 1834; by J. B. French between 1840 and 1850; and by T. B. Flower in 1868. Although the calyx-segments vary in length, these specimens appear to be typical *S. asperum*. Flower *in litt.* states that "it grows to a height of 6 or 7 ft., and was introduced 60 or 70 years ago as fodder for horses"; and Dr. Boswell writes in 1879—"I have examples from Bath, collected by Mr. French more than 30 years ago, but it appears to be extinct there now; though the dubious plant *S. uplandicum*, Nym., or *S. peregrinum*, Baker, still grows there." During the years 1910–12 I have searched carefully in the Oakford Valley, without finding any plant approaching *S. asperum*, but *S. peregrinum* grows there abundantly, with *S. officinale* and several different hybrids between the two species.

The form with large leaves was cultivated at Knutsford, Bowden, in 1862, and that with small elliptic leaves was collected by H. Barbey at Silverdale, Lancashire, in 1864. Dr. Boswell cultivated it (the Bath plant?) at Balmuto, together with *S. peregrinum* or the hybrid *S. cæruleum*, Petitm. It was gathered by A. Ley as *S. orientale*, Linn., at Lane End in 1881, and at Buckland as *S. asperum*, Lepech., in 1894. The living plants sent by Mr. Lynch from the Cambridge Botanic Garden are comparatively small and slender; the stems are more densely setose than in most native plants, and well illustrate the observation made above, that when the setæ are crowded they are not so prickle-like as when they are few and scattered. This form is found also in other botanic gardens, as there are specimens in the Geneva herbaria which were cultivated in the Botanic Gardens of that city and of Paris early in the last century.

S. asperum appears to be much rarer as a naturalized plant in Britain than *S. peregrinum*. The only specimens I have seen which have been gathered in recent years were collected by the Rev. H. J. Riddelsdell at Fairford, Gloucestershire, in 1908. These are typical examples of the narrow-leaved form, with the stem asperous with tubercular setæ, subpetiolate upper leaves, and small calyx with oblong obtuse segments.

4. S. PEREGRINUM, *Ledeb., Index. Sem. Hort. Dorpat.* p. 4 (1820).

Radix crassa, fusiformis, ramosa. *Caulis* elatus, ramosus, setis reversis interdum tuberculatis hispidus. *Folia* molliter hispida vel tuberculato-setosa, inferiora longe petiolata, elliptico-lanceolata, ovata oblongave, acuminata, basi cordata, rotundata vel subattenuata, in petiolum decurrentia, superiora ovata, acuminata, sessilia, laminâ ad caulem uncinato-adnatâ. *Racemi* multiflori. *Rachis* pedicellique setis rigidis patentibus hispidi. *Calyx* puberulus hispidulusque, in lacinias triangulari-lanceolatas sensim acuminatas ad tertiam partem inferiorem fissus, fructifer auctus, valde tuberculato- setosus. *Corolla* rosea, denique cærulea, calyce triplo quadruplove longior. *Fornices* late triangulari-subulati, obtusiusculi, stamina æquantes vel excedentes. Antheræ filamenta subæquantes. *Stylus* infra apicem sæpe infractus. *Nuculæ* supra basin constrictæ, curvatæ, valde venoso-areolatæ, tuberculatæ.

Caulis 1–2 m. et ultra altus; folia radicalia 20–26 cm. longa, 7–13 cm. lata, caulina media 10–16 cm. longa, 3·5 cm. lata, summa 5–7 cm. longa, 1·5–2 cm. lata; flores 15–20 mm. longi; calyx 5–7 mm. longus, fructifer 11 mm. longus; corolla 12–18 mm. longa; nuculæ 4–5 mm. longæ, 2·5–3 mm. latæ.

S. peregrinum, Ledeb., DC. Prod. x. p. 37 (1846); Ledeb. Fl. Ross. iii. p. 114 (1846–51).

S. officinale v. *patens*, Syme, Eng. Bot. t. 1516 (1867).

S. uplandicum, Nym. Syll. Fl. Eur. p. 80 (1854–5) *p. p.*

S. asperum × *officinale* (*S. peregrinum*, Ledeb.?), Baker in Rep. Bot. Exc. Club, p. 17 (1878). (See *Jour. Bot.* viii. p. 250 (1879)).

S. peregrinum, Ledeb., Hooker in Journ. Bot. ix. p. 57 (1880), and Bot. Mag. t. 6466 (1879); Boiss. Fl. Orient. iv. p. 175 (1879) *p. p.*

S. Donii, DC.?, Boswell in Jour. Bot. ix. p. 381 (1880).

S. peregrinum, Ledeb., Aschers. & Gräb. Fl. Nordostd. Flachl. p. 577 (1898–99); Kusnez. Cauc. Sp. Gen. Symph. p. 31, t. i. f. A, 4 & 8 (1910).

GEOGR. DISTR.—RUSSIA: Province of Talysch. PERSIA. TURCOMANIA (Kusnezow).

SPECIMENS EXAMINED:—Native. None.

CONTINENTAL, *cultivated or naturalised.*—S. tuberosum, "Ex horto Genevensi," 1820–30. *Herb. Bailey* and *S. Lond. Bot. Inst.*—S. peregrinum, Hort. Bot. Paris, 1835. *Herb. Cons. Bot. Genev.*—S. echinatum, Ledeb. S. officinale ex Mor. Hort. Genev. 1839, venu du Jardin de Paris. *Herb. DC.*—S. peregrinum, Ledeb. Cult. in hort. bot. Dorpatens. Fischer, 1840. *Herb. DC.*—S. echinatum, Ledeb. Hort. Dresden. Auerswald, 1841. *Herb. Mus. Brit.*—S. uplandicum, Nym. Upsala. Ahlberg, 1868. *Herb. Bailey.*—S. asperrimum, Bieb. Plauen, Saxony. Artz, 1882.—S. orientale, Linn. "Regio Aböensis," Finland. H. Hollman, 1885. *Herb. Bailey* and *J. W. White.*—S. asperrimum, Bieb. Westfalen. Holtzwickede, 1885. *Herb. Bailey* and *S. Lond. Bot. Inst.*—S. asperum, Lepech. Upsala, 1889. *Herb. Bailey.*—S. orientale, Linn. Län Kopparberg pr. Hedemora. Ringselle, Dörfler Herb. Norm. No. 4479, 1903. *Herb. Cons. Bot. Genev., Bailey, Bicknell,* and *S. Lond. Bot. Inst.*

BRITISH:—S. asperrimum. Marlborough, Wilts. J. B. Benson, 1861. *Herb. Mus. Brit.*—S. officinale v. patens. Arnside, Westmoreland, 1876. *Herb. Bailey.*—S. uplandicum, Nym. Balmuto, Fife, cult. Boswell, 1876. *Herb. Bailey.*—S. peregrinum. Grange Mill, Derby. W. H. Purchas, 1878. *Herb. G. C. Druce.*—"Purple Comfrey." Odiham, Hants. C. E. Palmer, 1883. *Herb. G. C. Druce.*—S. asperrimum. Kidderminster. F. A. Lees, 1883. *Herb. Mus. Brit.*—Foy, Hereford. A. Ley, 1886. *Herb. Bailey.*—Near Cliffe Station, W. Kent. E. S. Marshall, 1892. *Herb. Mus. Brit.*—S. peregrinum, Ledeb. Postbridge, Dartmoor. S. T. Dunn, 1893.—*Herb. C. Bucknall.*—S. officinale v. patens. Brass Knocker Hill, Bath. J. W. White, 1892. *Herb. G. C. Druce.*—S. asperrimum. Buckland, Devon. E. S. Marshall, 1894. *Herb. Mus. Brit.*—S. peregrinum, Ledeb. Cumnor, Bucks, 1896. *Herb. G. C. Druce.*—Doulting, Somerset. S. T. Dunn, 1897. *Herb. C. Bucknall.*—S. peregrinum, Ledeb. Helston, Cornwall. A. O. Hume, 1899. *S. Lond. Bot. Inst.*—S. officinale, Linn. Gerrans, Cornwall. F. N. Davey, 1900. *S. Lond. Bot. Inst.*—S. peregrinum, Ledeb. Tetbury Road, Glos., 1900. *Herb. Bailey.*—Ballingham, Hereford. A. Ley, 1900. *Herb. G. C. Druce.*—Blairgowrie, Perth. E. S. Marshall, 1906. *Herb. Mus. Brit.*—Bishops Cleve, Glos. C. Bailey, 1910.—Colyton, Devon. I. Roper, 1911.—Blackford Hill, Edinburgh. McTaggart Cowan, 1911.—Oakford Valley, Bath. C. Bucknall, 1911–12.—Arnside, Westmoreland. E. M. Holmes, 1911.—Thurso, Caithness. C. E. Moss, 1912.—Living plants from numerous localities in the counties of Gloucester and Somerset in the neighbourhood of Bristol have also been examined.

S. peregrinum is, with the possible exception of *S. asperum*, the largest species of the genus, attaining a height of 2 m. or more, with the stem 3 cm. in diameter at the base. From *S. officinale* it is distinguished by its greater size, by the stem, in pure-bred plants, not being winged, by the clear blue flowers, and by the tuberculated nutlets. From *S. asperum*, which it greatly resembles, it is distinguished by the generally less strongly tubercular-setose stem, by the upper leaves, which are sessile and adnexed to the stem by an uncinate prolongation of the blade of the leaf,—not subpetiolate, and especially by the larger calyx with acute segments. This applies to typical *S. peregrinum*, but intermediate forms sometimes occur in which the stem is more or less tubercular-setose, the calyx larger or smaller with more or less obtuse segments, and the corolla varying in size in relation to the calyx. Such forms are found naturalized in Britain and Sweden, but not, apparently, mixed with the typical plant. Kusnezow gives localities for an intermediate form in Transcaucasia, where the areas of the two species approach nearest to each other. I have seen no specimen of this. *S. peregrinum* is native on the banks of streams in the province of Talysch, in the extreme south-east of Transcaucasia, where it ascends to 8000 ft., and also, according to Kusnezow, in Persia and Turcomania. It does not appear to encroach on the area of *S. asperum*, except in the case of the intermediate forms mentioned by Kusnezow. It was cultivated in the botanic gardens of Geneva and Paris between 1820 and 1835, and has since been introduced into Britain and Sweden and other European countries. On account of its similarity to *S. asperum*, its tendency to hybridize with *S. officinale*, incomplete descriptions and the absence of authentic specimens, it has been much misunderstood and misnamed. It will be well, therefore, with a view to a better understanding of its position in relation to the species mentioned, to review its history more fully than was done in the Introduction.

Ledebour, although he does not describe the root, the colour of the flowers or the nutlets, either in the 'Index Seminum' or in the 'Flora Rossica,' sufficiently well distinguishes this species from *S. asperum*. The following is taken from Sir J. Hooker's account of t. 6466 in the 'Botanical Magazine,' and is presumably a copy of Ledebour's original description :—"*S. peregrinum* : caule elato ramoso setis subreversis hispido, foliis inferioribus longe petiolatis elliptico lanceolatis acuminatis superioribus sessilibus, omnibus molliter hispidis ciliatisque, petiolis decurrentibus, calyce fere ad basin 5-partito, segmentis triangulari-lanceolatis sensim acuminatis hispidulis, corolla calyce triplo v. quadruplo longiore, tubo angulato medio constricto, supra medium subcampanulato, ore breviter 5-fido, dentibus latis apicibus recurvis, appendicibus antheras subæquantibus." The 'Flora Rossica' description is as follows :—

"*S. peregrinum* caule setis subreversis hispido superne ramoso, foliis puberulis setisque rarioribus adspersis ciliatis ; inferioribus longe petiolatis oblongis acutis in petiolum decurrentibus; superioribus ovatis subacuminatis sessilibus, calycis sub-5-partiti laciniis lanceolatis acutiusculis, corollæ lobis semiorbiculatis erectis, appendicibus filamentisque antheras superantibus, stylo infra apicem infracto. Hab. in provinciis caucasicis (in tractu Suwant provinc. Talüsch), alt. 666 hexap. (Hohenack.)." The peculiar character of the bent style is here given for the first time. It is frequently found in *S. peregrinum*, and more rarely in *S. asperum* and in a few other species.

Sprengel's description, which is very meagre and doubtfully applicable to this species, must here be given on account of the use made of it by De Candolle in the 'Prodromus.' "S. caule ramoso, nudiusculo, foliis inferioribus oblongis longe petiolatis hirsutis, superioribus ovatis basi inæqualibus sessilibus glabriusculis, calycibus 5-partibus villosis. Podolia." It will be seen that there is nothing in this description to identify it with *S. peregrinum*, and the expression "caule nudiusculo" is distinctly against it. The locality, Podolia, is a long way from the area of *S. peregrinum*, and, except as a cultivated plant, it is most unlikely that it would be found there. The probability is that Sprengel's plant is one of the *S. officinale* group, perhaps *S. tanaicense*, Steven, as is, indeed, suggested by Steven himself, with regard to both Sprengel's and De Candolle's descriptions.

Unfortunately, De Candolle took this as the basis of his description in the 'Prodromus,' instead of Ledebour's description, and supplemented it by characters taken from a specimen sent to him by Dr. Fischer from the Dorpat garden, the origin of which was presumably the province of Talysch. Having seen this specimen, I have no doubt that it is true *S. peregrinum*, but not sufficiently complete to furnish a good description. The 'Prodromus' diagnosis is as follows:—"*S. peregrinum* (Ledeb. ex Spreng. Syst. i. p. 563) caule glabriusculo ramoso nudiusculo, foliis pilis setisque rarioribus puberulis inferioribus longe petiolatis ovatis oblongisve subacutis, superioribus sessilibus ovato-acuminatis basi inæqualibus, racemis laxifloris, calyce sub-5-partito, hispidulo lobis lanceolatis post anthesin basi latioribus et divergentibus, corollâ infundibuliformi calyce duplo longiore, appendicibus lineari-attenuatis, obtusis, stamina superantibus.

"In Podoliâ (Spreng.), ad Suwant alt. 4000 p. (Hohen. pl. per prov. Talysch, p. 77). Folia radic. limbo 4 poll. longo in spec. super. 1–1½ poll. longa. Flores 6 lin. longi. Calyx fructifer pedicello duplo longior. Cor. purpuræ? glabræ. Antheræ utrinque emarginatæ filamento breviores. Affinis *S. caucasico* sed calyx diversus. (Alph. DC. v. spec. ex h. Dorpat. a cl. Fisch. comm. et descripsit.)"

Mention has already been made of the inapplicability of Sprengel's term "nudiusculo" to the stem of this plant, and the same must be said of the term "glabriusculo," as the stem is generally rather densely hispid. Other points in which De Candolle's description is misleading are: the small size of the radical leaves—4 in. long—although one of the lower leaves in the Dorpat specimen measures about 9 in. in length; and the colour of the flowers, which, not having seen them in the fresh state, he gives as "purpuræ?" These discrepancies, together with the other difficulties which I have mentioned, have served to perplex botanists, and it is not surprising that they should have hesitated to accept the naturalised plant as a true species, or as that described by Ledebour, but that they should have looked upon it as a variable hybrid between *S. asperum* and *S. officinale,* or as a cultivated form of one of these species.

About the year 1861 *S. peregrinum* began to attract attention as a naturalised plant in England, and was then and for some years after variously named *S. asperrimum*, *S. officinale* var. *patens*, and *S. uplandicum*, Nym.

In the 'Report of the Botanical Exchange Club' for 1877–8, Mr. J. G. Baker suggested the name of *S. peregrinum*, Ledeb., with the remark that it is perhaps "a garden hybrid between *S. asperum* and *S. officinale*, which is most likely *S. peregrinum*, Ledeb." Then Boissier in the 'Flora Orientalis,' iv. p. 175 (1879) states his opinion that this and also *S. echinatum*, Ledeb., are "formæ hortenses forsan hybridæ." But Sir Joseph Hooker in the following year (Bot. Mag. 1879, t. 6466) quotes Ledebour's description and says that he considers that there is no evidence of hybridity, but that he regards it as a large form of *S. officinale* probably originating from cultivation and not from hybridity. In the 'Journal of Botany,' 1880, p. 381, Dr. Boswell Syme writes: "It seems to agree better with De Candolle's description of *S. Donii* than with his or Ledebour's description of *S. peregrinum*, as the leaves, especially the upper ones, are shortly decurrent." (See note on *S. Donii*, p. 528.)

Having studied all available specimens, both living and dried, and carefully compared them with, I believe, all the published descriptions, I am convinced that we have Ledebour's plant in Britain, and that it is a true species, which, when pure bred, produces fruit abundantly; that, as I have shown in 'Journal of Botany,' vol. l. (1912) p. 332, when it grows in company with *S. officinale*, it hybridises with it and produces a series of forms which are more or less similar to one or other of the parents. One of these, with semi-decurrent leaves and blue flowers, which I refer to *S. cœruleum*, Petitmengin, has been widely distributed by root division, and has occasioned much of the difficulty in deciding on the status of this plant. Lastly, there are intermediate plants between *S. asperum* and *S. peregrinum*, possibly hybrid, but more probably the result of difference of climate, soil and situation. I have seen such forms from Kidderminster; Cliffe Station, West Kent; Sandling Junction, East Kent; Buckland, Devon; Colyton, Devon; Blackford Hill, Edinburgh; and Arnside, Westmoreland. Plants from the last locality, kindly sent by Mr. E. M. Holmes, were cultivated at Clifton together with a local plant which is nearly normal *S. peregrinum*. Although dried specimens of the former appeared to approach *S. asperum*, especially in the character of the clothing, when they grew together the two plants were indistinguishable.

The appearance of Kusnezow's work, with a figure and an excellent and complete description of this species, has confirmed me in the opinion that our plant, *when pure bred,* is that described by Ledebour.

5. S. SEPULCRALE, *Boiss. & Bal., in Boiss. Fl. Orient.* iv. p. 174 (1879).

Caulis elatus, sulcatus, ramosus, puberulus, pilis rectis deflexis minute tuberculatis obsitus. *Folia* membranacea, ampla, ovato-oblonga, acuta vel acuminata, basi rotundata vel cordata, tuberculis sparsis muticis et breviter setigeris obsitis, inferiora petiolata, superiora sessilia. *Rachis* pedicellique pilis longis sursum curvatis vestiti. *Calyx* vix ultra medium in lacinias lineares obtusissimas pilis longis ciliatas fissus, fructifer accretus. *Corolla* violacea, calyce duplo quadruplove longior. *Fornices* late lineares, stamina æquantes vel superantes. *Antheræ* breves, filamenta vix æquantes. *Nuculæ* 1–2 rugis tantum obsitæ, læves et nitidæ vel areolatæ et minute tuberculatæ.

Folia inferiora 8·5–16 cm. longa, 5·5–10 cm. lata ; flores 15 mm. longi ; calyx 6 mm.; corolla 13 mm. longa ; nuculæ 3–3·5 mm. longæ, 2·5 mm. latæ.

GEOGR. DISTR.—TURKEY : Lazistan.

S. sepulcrale, Boiss. & Bal. in Bal. Pl. Pont. 1866.

SPECIMENS EXAMINED :—Symphytum Cappadocicum, *folio subrotundo aspero, flore cœruleo.* Cor. I. R. H. 7. *Herb. Sherard* in *Herb. Fielding.*—S. sepulcrale, Boiss. & Bal. . Cimitière Turc de Djimil, Lazistan, à 2032$^{\mathrm{m}}$., Bal. No. 1514 (1866). *Herb. DC., Boissier* and *Kew.*—Djimil. René de Parquet, 1866. *Herb. Mus. Brit.*—Boejükdere supra Artabir, Armenia. P. Sintensis, No. 7038, 1894. *Herb. Kew., Mus. Brit.*, and *Bailey*.

Easily recognised by the oblong, obtuse calyx-segments which are almost truncate at the apex and ciliate with long spreading hairs. In the Djimil specimen the nutlets are smooth and shining, as described by Boissier, but in some at least of the Boejükdere plants they are venoso-reticulate and minutely tuberculated.

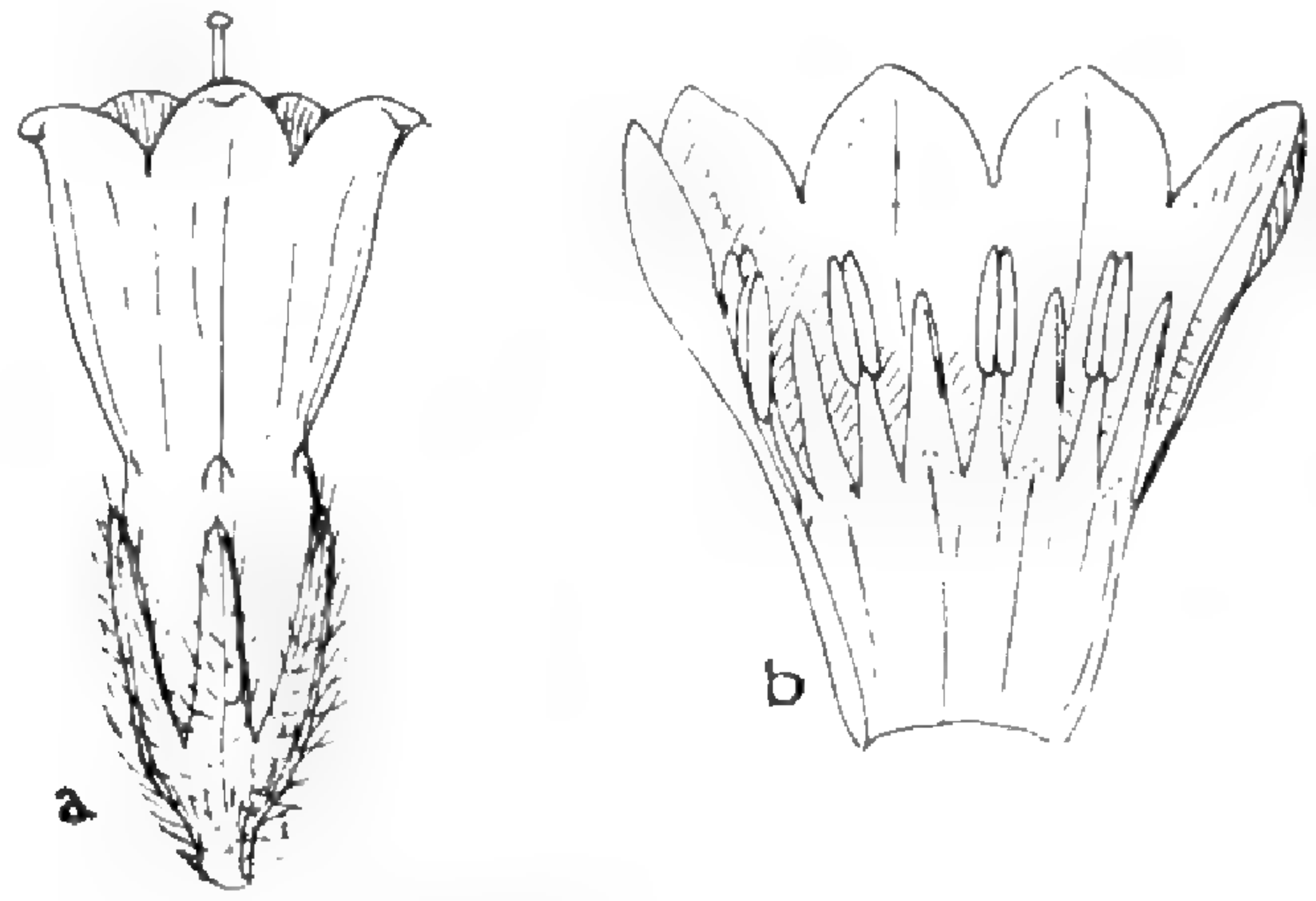
It differs from *S. armeniacum* in the leaves being petiolate and rounded or cordate at the base, by the slender hairs of the stem, and by the more deeply divided calyx, the segments of which bear long cilia on the margin. The specimen in the Sherard herbarium anticipates its collection by Balansa by more than 150 years. It consists only of a branch with a pair of leaves and racemes, but agrees in all respects with Balansa's plant.

6. S. ARMENIACUM, sp. nov.*

Caulis puberulus et aculeis crassis unguiformibus albidis aspersus, ramosus. *Folia* puberula et minute tuberculato-setosa, radicalia ovato-

oblonga, acuta, basi subcordata, in petiolum alatum decurrentia, caulina inferiora oblonga, acuta, basi attenuata, superiora ovato-lanceolata, acuminata, summa anguste lanceolata, omnia sessilia, semiamplexicaules, non decurrentia. *Racemi* multiflori. *Rachis* pedicellique dense uncinato-pubescentes setosique. *Calyx* hispidus, ultra tertiam partem inferiorem in lacinias lineares obtusas ciliatas fissus. *Corolla* violacea, calycem duplo subtriplove superans. *Fornices* late lineares, obtusi, staminibus longiores aut breviores. *Antheræ* basi obtusæ filamenta æquantes.

Fig. 1.



Symphytum armeniacum.
a. Flower. *b.* Corolla, opened to show stamens and corolla-scales. × 2.

Caulis (in specimenibus incompletis) 3–3·5 dcm. altus; folia radicalia 2·5 dcm. longa, 1·2 dcm. lata, caulina inferiora 13 cm. longa, 5 cm. lata, summa 3–5 cm. longa, 1–1·5 cm. lata; flores 13–18 mm. longi; calyx 5–7 mm. longus; corolla 13–15 mm. longa.

GEOGR. DISTR.—RUSSIA: Georgia, Caucasus. TURKEY: Armenia.

SPECIMENS EXAMINED:—S. asperrimum (No. 286) and S. caucasicum, Bieb. Georgia, Cauc. T. F. Hohenacker, 1831; S. caucasicum, Bieb. Georgia, Cauc. R. T. Hohenacker, 1838. *Herb. Fielding.*—S. sp., Erzerum. Calvert, No. 222 (recd. 1867). *Herb. Univ. Cantab.* and *Fielding.*—S. asperrimum, Sims. In montibus pr. Nachitschewan (Transcaucasia). P. Buhse, 1893. *Herb. Kew.*

When I first recognised this as an undescribed species, and as distinct from the other members of the *Cærulea*, the specimen in the Cambridge herbarium was the only one that I had seen. This was collected in Armenia by Calvert (No. 222), at some time previous to 1866. As far as I was aware, no other specimen existed either in the British or Genevan collections, until, on examination of the Fielding herbarium, I found several plants which were undoubtedly the same. One of these is Calvert's No. 222; three others, collected in Georgia by the Hohenackers in 1831 and 1838, are named, one of them *S. asperrimum*, and two others *S. caucasicum*. As other plants so named by the same collectors are typical, this is an instance of the confusion which arises when two names have to serve for three different species.

S. armeniacum is most nearly allied to *S. asperum* and *S. sepulcrale*, but differs from both in the sessile clasping leaves; from *S. asperum* it is clearly distinguished by the larger calyx with elongated linear segments, and from *S. sepulcrale* by the more setose and prickle-like clothing, and by the more deeply divided calyx. It need not be confused with *S. caucasicum*, which has the lower leaves gradually attenuated into the petiole, the upper partially decurrent and the calyx-segments shorter than the tube.

It may be noted that, of the four members of this group, the distribution as far as is known, is as follows:—*S. sepulchrale* is found furthest west, in the neighbourhood of Trebizond; *S. armeniacum* comes next in Armenia and Georgia; here the area of *S. asperum* commences and extends northwards in the Caucasus, while that of *S. peregrinum* extends southwards and eastwards from the south-east of the Caucasus into Persia.

7. S. TAURICUM, *Willd. in Neue Schrift. Nat. Berl.* ii. p. 120, t. 6. fig. 1 (1799).

Radix fusiformis. *Caulis* pilosus aut parce tuberculato-setosus, ramosus. *Folia* molliter tenuiterque puberula et setoso-pilosa, ovata vel ovato-oblonga, acuta, bullata, margine subundulata, inferiora petiolata, basi cordata vel rotundata, media breviter petiolata, petiolis ad basin marginatis, summa ovata, acuminata sessilia. *Rachis* pedicellique pilis sursum curvatis vestiti. *Calyx* pilosus, ad tertiam partem inferiorem in lacinias lanceolatas, acutas vel obtusiusculas fissus. *Corolla* flavo-albida, calyce duplo triplove longior. *Fornices* late lineares, obtusi, stamina æquantes. *Antheræ* basi apiculatæ, filamenta subæquantes. *Nuculæ* curvatæ, venoso-areolatæ, tuberculatæ.

Caulis 3–4 dem. altus; folia caulina inferiora 5·5–7·5 cm. longa, 3–4·5 cm. lata; flores 10–12 mm. longi; calyx 5–6 mm. longus; corolla 9–14 mm. longa; nuculæ 2·5 mm. longæ, 1·5 mm. latæ.

S. bullatum, Hornem. Cat. Hort. Havn. Supp. 2, p. 13, et Hort. Reg. Havn. i. p. 179 (1813); Jacq. fils, Eclog. i. p. 119, fig. 81 (1811–16).

S. tauricum, Willd., Sims, Bot. Mag. t. 1787 (1816).

S. bullatum, Hornem., Roem. & Schultes, iv. p. 66 (1819).

S. tauricum, Willd., Reich. Pl. crit. t. 260. fig. 442 (1825); DC. Prod. x. p. 39 (1846); Ledeb. Fl. Ross. iii. p. 116 (1846–51); Kusnez. Cauc. Sp. Gen. Symph. p. 41, t. i. figs. 9 & 11 (1910).

GEOGR. DISTR.—RUSSIA: from Podolia to the Crimea.

SPECIMENS EXAMINED:—*Native*. S. orientale. In ripis fluviorum Tauriæ. *Herb. Pallas* in *Herb. Mus. Brit.*—S. sp., e Podolia austr. *Herb. W. Besser* in *Herb. Kew.* and *Mus. Brit.*—S. tauricum, Willd. Sudak, Crimea. M. Léveillé. *Herb. Cons. Bot. Genev.*—S. orientale, Biçb. non Linn. Linia pr. Odessa. Herb. Ruth. cent. i. no. 91. Láng & Szovits. *Herb. Kew.* and *Univ. Cantab.*—S. orientale, Linn. Chrebet-Jaila, Kisiltasch, Kaban

Territory (1896). *Herb. Bailey.*—S. tauricum, Willd. Burultscha, Karasubasar. A. Callier, No. 676 (1900). *Herb. Cons. Bot. Genev., Bailey*, and *Bicknell.*

Cultivated and naturalised.—S. bullatum. Herb. Swainson (1817). *Herb. Univ. Cantab.*—S. tauricum, Hort. Monsp. Herb. Bentham (1820). *Herb. Kew.*—S. bullatum. Bot. Gard. Camb., J. S. H. (1826). *Mus. Henslow* in *Herb. Univ. Cantab.*—S. tauricum, Hort. Miller (1826). *Herb. Univ. Cantab.*—S. bullatum. Cobham Lodge (1828). *Herb. Kew.*—S. bullatum, Hornem., Jard. de Genève. *Herb. de Moricand* in *Herb. Cons. Bot. Genev.*—S. orientale. Allesley, Warwick. T. Kirk (1854) (observed in 1849). *Herb. Mus. Brit., Univ. Cantab.*, and *Bailey.*

This is distinguished from *S. orientale*, which it resembles in the cordate leaves, by the deeply divided calyx with lanceolate segments. *S. grandiflorum*, DC., has been taken for *S. tauricum*, but differs greatly in the creeping root with decumbent leafy shoots and simple flowering stem with few-flowered racemes. *S. bullatum*, Hornem., is said to differ in the smaller leaves of a darker green, the more hispid stem, the hairs with purple glands at the base, and the more inflated, pale corolla. The Allesley plant was mentioned as a garden escape by Syme in 'English Botany' in 1867, and he states that it had also been found on a hedge-bank near the Observatory at Cambridge, but specimens from this locality belong to *S. orientale.*

8. S. SYLVATICUM, *Boiss., Fl. Orient.* iv. p. 172 (1879).

Viridis. *Caulis* gracilis, ramosus, setis retrorsis basi tuberculatis strigosus. *Racemi* breves, pauciflori. *Folia* tenera, oblongo-lanceolata, acuminata, denticulata, in petiolum brevem attenuata, paginâ superiore sparsim et subtus ad nervos breviter tuberculato-setosâ, summa diminuta, sessilia. *Calyx* ad medium in dentes lineares obtusos fissus, fructifer parum auctus, campanulatus. *Corolla* alba, calyce subtriplo longior. *Fornices* late lineares, stamina superantes. *Antheræ* filamentis æquilongæ. Nuculæ parvæ, subglobosæ, obliquæ, areolato-rugulosæ, læves vel minute tuberculatæ, nitidæ.

"Folia ea Impatientis noli tangere referentia, inferiora 2½–3½ pollicaria longa, 12–15 lin. lata, racemi breves 5–7-flori foliosi, nuculæ lineam latæ apice obliquo. Formâ foliorum, nuculis lævibus etc., ab affine *S. taurico* distinctum."

GEOGR. DISTR.—TURKEY: Northern Asia Minor.

SPECIMEN EXAMINED:—Calia, Trebizond. E. Bourgeau. Exsic. Armen. (1862). *Herb. Boiss.*

On the sheet is written—"S. sylvaticum, sp. nova, à placer près de l'Anatolicum Boiss. de laquelle elle se distingue par les grappes pauciflores, les fruits plus gross et plus courts, plus fortement nervés-reticulés." Leaves thin, conspicuously tuberculato-setose; corolla-scales broad, longer than the stamens; nutlets strongly reticulato-rugose, shining but minutely tuberculated.

This is one of the species whose range is, as far as is known, extremely limited. The above specimen is the only one contained in the herbaria which I have examined. It exactly corresponds with Boissier's description.

9. S. ANATOLICUM, *Boiss.*, *Diag.* ser. I. iv. p. 43 (1844).

Radix simplex vel ramosa. *Caulis* minute puberulus et setis rigidis tuberculo insidentibus asper, gracilis, sulcatus, flaccidus, fere a basi subdichotome ramosus. *Folia* puberula et tuberculato-setosa, tenera, subrepanda; inferiora ovata vel oblonga in petiolum brevem, marginatum attenuata vel subcontracta; summa sessilia, interdum breviter et anguste decurrentia. *Racemi* sæpe multiflori, tandem laxi. *Rachis,* pedicelli calycesque setis longis rectis patentibus obsiti. *Calyx* viscidus, ad tertiam partem inferiorem in lacinias lineari-lanceolatas obtusiusculas fissus, fructifer deflexus, accretus, laciniis a basi ovata attenuatis glabrescentibus. *Corolla* alba vel violacea, calyce duplo longior. *Fornices* late lineares, obtusi, stamina vix superantes. *Antheræ* filamenta paullo excedentes. *Nuculæ* rectiusculæ, venoso-areolatæ, tuberculatæ.

Caulis 4–6 dcm. altus; folia inferiora 5–11 cm. longa, 2–4·5 cm. lata, superiora 2–5 cm. longa, 1·2 cm. lata; flores 10–13 mm. longi; calyx 6–7 mm. longus, fructifer 9–12 mm. longus; corolla 9–11 mm. longa; nuculæ 2–2·3 mm. longæ, 1·2–1·5 mm. latæ.

S. anatolicum, Boiss., DC. Prod. x. p. 39 (1846); Boiss. Fl. Orient. iv. p. 173 (1879).

S. sicyosmum, Candargy in Bull. Soc. Bot. Fr. xliv. (1897) p. 150.

GEOGR. DISTR.—TURKEY: Asia Minor.

Subvar. ALBIFLORUM, *Boiss.*

HAB. Smyrna, Tmolus, Yaïla de Bozdagh.

Subvar. VIOLACEUM, *Boiss.*

HAB. Cos, Mesogis.

SPECIMENS EXAMINED:—Symphytum sp. Herb. Sherard in *Herb. Fielding.*—S. asperrimum. Sommets de la Cos. D'Urville, Mai, 1820? *Herb. DC.*, and *Kew.*—S. anatolicum, Boiss. Mesogis super Tralles (Aidin, Asia Minor), 1842. *Herb. E. Boiss.* in *Herb. Kew.* and *Univ. Cantab.*—Smyrna, 1842, *Herb. E. Boiss.* in *Herb. Kew.*—*α.* albiflorum, Boiss. Montes Smyrnæ, E. Boissier, 1844. *Herb. Kew.*, *DC.*, and *Univ. Cantab.*—Yaïla de Bozdagh, Tmolus occid. B. Balansa, Pl. d'Orient, No. 368, 1854. *Herb. Mus. Brit.*, *Fielding*, and *DC.*—In monte Dikios, Kos in insulis Archipelagi. Dr. Forsyth Major, 1887. *Herb. Kew.*—In Monte Sipylos, Magnesia, Lydia. Bornmüller, No. 9789, 1906. *Herb. Mus. Brit.*—Sinus Smyrnæus, Ilidja, in valle Soghandere, Lydia. J. Bornmüller, Pl. exsicc. Lydiæ et Caricæ, No. 9792, 1906. *Herb. Kew.*; No. 9790. *Herb. Mus. Brit.*

This is a small, slender species, distinct and easily recognised. De Candolle mentions a "specimen simplex subpedale," but all those which I have seen are copiously branched with numerous, mostly many-flowered, branches. The leaves are rough with tubercular setæ, and are generally attenuated into the petiole, but are occasionally rounded at the base, as in Bornmüller's plant from Mount Sipylos. The racemes often bear as many as 36 flowers, as in Boissier's Smyrna plant, but in his plant from Tralles they are as few as 12.

Flowers of two distinct colours are rare in this genus, only occurring, in pure species, in this and in *S. officinale*. In the latter, two colours are often combined in the same flower, but in *S. anatolicum*, as far as can be seen in dried specimens, they are either pure violet or white. The corolla is generally narrow, and the tube is nearly twice as long as the limb. In fruit, the calyx-segments are broadly ovate at the base, rather suddenly attenuated to the apex, and become nearly glabrous.

In the absence of specimens it seems impossible to separate *S. sicyosmum*, Candargy from *S. anatolicum*. The only characters in which Candargy's description differs are—the leaves contracted instead of attenuated into the petiole, the rather more deeply divided calyx, with segments which are acute instead of subobtuse, and the corolla-scales which are often bifid at the apex. But these characters of the leaves and calyx are variable in *S. anatolicum*, as in most species, and can scarcely constitute a species or even a variety, and the bifurcation of the corolla-scales is probably an abnormality, which occasionally occurs in other species. There only remains the taste of cucumber mentioned by Candargy, but this again, without more definite characters, is insufficient to separate the plant from *S. anatolicum*, and is, indeed, found to a certain extent in other species. The habitat, the island of Lesbos, is not too far away to be included in the area of *S. anatolicum*, being not further from Smyrna than Tralles and Mount Tmolus.

10. S. OTTOMANUM, *Friv.*, *in Flora*, xix. (1836) p. 439.

Radix fusiformis. *Caulis* puberulus et pilis longis minute tuberculati hirsutus, gracilis, suberectus, ramosissimus, ramis elongatis gracilibus. *Folia* hispidiuscula, ovata oblongave, acuta; inferiora cordata et media in petiolum alatum contracta vel attenuata, nec in caulem decurrentia; superiora sessilia, basi cuneata. *Racemi* multiflori, demum elongati. *Rachis* pedicelli calycesque pilis longis gracilibus rectis et uncinatis obsiti. *Calyx* ad tertiam vel quartem partem inferiorem in lacinias ovato-lanceolatas subulatasve, subobtusas fissus. *Corolla* subcylindrica, ochroleuca, calycem dimidio subduplove excedens. *Fornices* subulati, acuti, longe exserti, corollâ duplo longiori. *Antheræ* filamenta subæquantes, basi utrinque apiculatæ. *Nuculæ* supra basin vix constrictæ, obsolete areolato-rugosæ, minute tuberculatæ.

Caulis 3–5 dcm. altus; folia 5–7 cm. longa, 2–4 cm. lata; flores 7–8 mm. longa; calyx 4–5 mm. longus; corolla 6–7 mm. longa; nuculæ 2 mm. longæ, 1·5 mm. latæ.

S. ottomanum, Friv., DC. Prod. x. p. 39 (1846) ; Reich. Fl. Germ. t. 104. fig. 1 (1858).

GEOGR. DISTR.—HUNGARY: Banat. SERVIA, BULGARIA. GREECE: Thessaly, Eubœa.

SPECIMENS EXAMINED :—S. ottomanum, Friv. Roumelia. Leg. Frivaldszky, 1837. *Herb. Kew.*—Banata ad Danubium. Szovits, 1853. *Herb. DC.*—S. bullatum. Plantes de Moldavia. Guebhard, 1870. *Herb. Kew.*—S. ottomanum, Friv. Rumelia inter Hvojna et Bučkovo. J. Wagner, 1892. *Herb. S. Lond. Bot. Inst.*—Ladros, Bulgaria. Det. Velenovsky, 1892. *Herb. Bicknell.*—Ad Susam, Bulgaria, 1898. *Herb. S. Lond. Bot. Inst.*—Chalski, Thessaly. P. Sintenis, No. 636, 1896. *Herb. Bailey* and *S. Lond. Bot. Inst.*—Servia, between Djep and Vladicin-Han. G. Flic. *Herb. J. W. White.*—Tschendem-tepé, Bulgaria. C. Kech & Th. Pichler. *Herb. Bailey* and *S. Lond. Bot. Inst.*

This has hitherto been placed with *S. bulbosum*, Schimp. in a section characterised by the exserted corolla-scales, but with that species it has no other affinity. It differs from it fundamentally in the fusiform root, the branched stem, and the many-flowered racemes. From *S. pseudobulbosum*, Azn., which has slightly exserted corolla-scales, it is distinguished by the more slender habit, the wingless stem, and the deeply divided calyx.

11. S. CAUCASICUM, *Bieb.*, *Fl. Taur.-Cauc.* iii. p. 128 (1808).

Radix fusiformis, ramosa. *Caulis* pilis mollibus uncinatis et sursum curvatis hirsutus, ramosus. *Folia* molliter pilosa, ovato-oblongove-lanceolata, inferiora in petiolum alatum longe attenuata, superiora anguste et breviter decurrentia. *Rachis*, pedicelli et calyx uncinato-setulosi. *Calyx* ad tertiam vel quartam partem in dentes late lineares vel triangulares obtusos partitus. *Corolla* cærulea, calyce duplo triplove longior. *Fornices* lineares, obtusi, stamina vix excedentes. *Antheræ* filamentis æquilongæ vel duplo longiores. *Nuculæ* venoso-areolatæ, minute tuberculatæ.

Caulis 3–6 dcm. altus; folia radicalia 20 cm. longa, 8 cm. lata, caulina 8–15 cm. longa, 4–6 cm. lata, vel 14 cm. longa, 3 cm. lata ; flores 13–17 mm. longi ; calyx 6–9 mm. longus ; corolla 12–14 mm. longa.

S. racemosum, Roem. & Schultes, Syst. iv. p. 752 (1819).

S. caucasicum, Bieb., Graham, New Edinb. Phil. Jour. p. 172 (1832) ; Curt. Bot. Mag. vi. t. 3188 (1832) ; Don in Sweet's Brit. Fl. Gard. ser. 2, iii. t. 294 (1835) ; DC. Prod. x. p. 38 (1846).

S. Donii, DC. Prod. x. p. 37 (1846).

S. caucasicum, Bieb., Ledeb. Fl. Rossica, iii. p. 115 (1846–52) ; Boiss. Fl. Orient. iv. p. 172 (1879) ; Kusnez. Cauc. Sp. Gen. Symph. p. 28, t. 1. figs. 2 & 6 (1910).

Geogr. Distr.—Russia: Caucasus and Transcaucasus.

Specimens examined:—*Native*. S. caucasicum, Bieb. Nosdoc Taurasi 1811. *Herb. Mus. Brit.*—S. sp. Caucasus, 1820. *Herb. W. H. Gower* in *Herb. Kew.*—S. asperrimum, Biehler. "Wilhelms misit ex Iberia" (government of Tiflis), 1824. *Herb. Kew.*—S. caucasicum, Bieb. Georgia, Caucasus. T. F. Hohenacker, 1831. *Herb. Kew.*, *Fielding* and *Univ. Cantab.*—S. orientale, Linn. Schuschia, Transcaucasia. Hohenacker, 1833. *Herb. Mus. Brit.*—S. caucasicum, Bieb. Georgia, Caucasus. "M. Wilmsen par Mme. de Hahn," 1838. *Herb. DC.*—Caucasus. Ledebour. *Herb. Univ. Cantab.*—Cartalina, Abastuman (government of Tiflis). *Herb. Mus. Brit.*—Caucasus. W. Massalsky. *Herb. Boissier.*

Naturalised or cultivated.—S. caucasicum, Bieb. Ex Hort. Soc. Pharm. Chelsea, 1849. *Herb. Thomas Moore* in *Herb. Kew.*—S. asperrimum. Chipping Norton Junction, Oxon. G. C. Druce, 1898.—Bruern, Oxon. G. C. D., 1901.—S. caucasicum, Bieb. Chelsea Physick Garden (living plant). Mr. W. Hales, 1911.

Var. glabriusculum, *DC.* "Caule ramosiore foliisque remotioribus pubescentibus, calycibus hispidis." *Folia* caulina, 14 cm. longa, 3·5 cm. lata.

Specimen examined:—S. caucasicum, β. glabriusculum, "du Caucas." Wilmsen, 1838. *Herb. DC.*

S. caucasicum is distinguished from the other blue-flowered species by the softly hairy stem and leaves, by the lower leaves, especially the radical ones, being gradually attenuated into the petiole, and by the tubular shortly toothed calyx. The leaves vary from broadly ovate, as in the Cartalina and Chelsea Garden plants, and in the figure t. 3188 of the 'Botanical Magazine,' to oblong-lanceolate, as in the Nosdoc and Georgia plants, and in those collected in Oxfordshire by Mr. G. C. Druce. Some autumnal radical leaves of the Chelsea Garden plant which flowered at Clifton in 1912, attained a large size (6 dcm. × 1·5 dcm.) with the blade of the leaf gradually attenuated nearly to the base of the petiole. The leaves are wrinkled and repand, as shown in t. 294 of the 'British Flower Garden.' The flowers are generally as described in the 'Botanical Magazine,' "red-purple then a lively azure," but in the Chelsea plant they were very pale blue, and of the same colour when the plant flowered at Clifton in the succeeding year, during several months of variable weather. This plant was completely sterile.

S. caucasicum appears to have been first introduced into Britain in 1830, when Dr. Fischer sent seeds from St. Petersburg to Edinburgh; the plants which sprung from these flowered in 1832. Seeds were also received at Chelsea from Dr. Fischer, probably at the same time, as Don's figure in the 'British Flower Garden' was taken from the resulting plants in 1835.

Mr. Hales tells me that there is no record of the origin of the present Chelsea plant, but from the length of time that species of *Symphytum* are known to persist in this country, it seems probable that it is a descendant of the original plants. There is a specimen at Kew, gathered at Chelsea in 1849, which is probably of the same stock.

On Don's figure of this plant, De Candolle founded a new species, which he described in the 'Prodromus' as *S. Donii*. The calyx-teeth in the figure are subulate, acuminate, almost equal to the tube, and in this it differs, as De Candolle says, from *S. caucasicum*. But in the description accompanying the figure the calyx is described as "5-angled tubular .... with 5 ovate, blunt, connivent teeth," which accurately represents that of *S. caucasicum*. In the figure, moreover, the calyx is drawn so narrow that there would not be room for the enclosed organs, and this, together with the limb of the corolla suddenly bulging out beyond the calyx-teeth, makes the flower unlike that of any species of *Symphytum*. This excepted, there is nothing in the drawing which separates it from *S. caucasicum*, and the description of the corolla-scales, "ligulate, blunt," exactly fits those of that species. There is no known specimen of *S. Donii*, and no botanist appears to have even seen one, although the name has occasionally been suggested for other species. It is clear, therefore, that *S. Donii*, being founded on an erroneous drawing, does not exist as a species.

The type specimen of var. *glabriusculum* in Herb. DC. has a much branched stem, with narrow decurrent leaves, and is thinly clothed with scattered hairs. Mr. G. C. Druce's Oxfordshire plants and other narrow-leaved forms may perhaps belong to this variety.

12. S. ORIENTALE, *Linn., Sp. Pl.* ed. I. p. 136 (1753), *pro parte*.

Radix fusiformis, ramosa. *Caulis* tenuiter puberulus et pilosus, ramosus. *Folia* conferte molliterque pubescentia, ovata vel oblonga, subacuta, basi cordata, truncata vel rotundata, inferiora petiolata, petiolis apice marginatis, summa sessilia. *Racemi* multiflori, fructiferi paullo elongati. *Rachis* pedicellique pilis sursum curvatis et uncinatis vestiti. *Calyx* tubulosus, ad tertiam vel quartam partem in dentes ovatos oblongosve obtusos ciliatos partito. *Corolla* alba, calyce duplo triplove longior, limbo late infundibuliformi. *Fornices* late subulati, subobtusi, stamina paullo excedentes. *Antheræ* basi apiculatæ, filamenta subduplo excedentes. *Nuculæ* curvatæ, supra basin constrictæ, venoso-areolatæ, tuberculatæ, nigro-fuscæ.

Caulis ad 6·5 dcm. altus; folia radicalia 14 cm. longa, 9 cm. lata, caulina 12 cm. longa, 7–8 cm. lata, vel 9 cm. longa, 3·5 cm. lata; flores 16–21 mm. longi; calyx 7–9 mm. longus; corolla 15–17 mm. longa; nuculæ 3 mm. longæ, 2–3 mm. latæ.

S. constantinopolitanum boraginis folio et facie, flore albo, Tournef. Cor. p. 7 (1703); Voy. i. p. 524 (1717); Buxbaum, ii. cent. 5, p. 36, t. 68 (1729).

S. orientale, Linn., Jacq. f., Eclog. i. p. 121, t. 82 (1811–16).

S. tauricum, Sims, Bot. Mag. t. 1912 (1817).

S. orientale, Lehm. Asperif. no. 225 (1818).

S. Jacquinianum, Tausch in Flora, xix. p. 392 (1836).

S. orientale, Linn., DC. Prod. x. p. 39 (1846); Ledeb. Fl. Ross. iii. p. 116 (1846–51); Boiss. Fl. Orient. iv. p. 171 (1879).

S. tauricum, Coste, Fl. Fr. ii. p. 582 (1903), non Willd.

GEOGR. DISTR.—Neighbourhood of Constantinople.

SPECIMENS EXAMINED:—*Native*. S. orientale, Constantinople. D'Urville, 1821. *Herb. DC.*—Anatolia. Ex Herb. Hort. Petrop. *Herb. Kew.*—Constantinople. Aucher-Eloy, 1837. *Herb. Cons. Bot. Genev.* and *Fielding.*—Eski Serai and Top-Karn Serai, Constantinople. Dr. Degen, 1890. *Herb. Bicknell.*

Naturalised or cultivated.—S. peregrinum, Ledeb. Podolia austr. *Herb. Besser* in *Herb. Kew.*—S. orientale. Chelsea Bot. Garden, 1824 and 1848. *Herb. Hew.*—Cambridge Bot. Garden, 1826. *Herb. Henslow* in *Herb. Univ. Cantab.*—Hort. Bot. Parisiensis, 1835. *Herb. Cons. Bot. Genev.*—Casterton, Rutland, 1837. *Herb. C. C. Babington* in *Herb. Univ. Cantab.*—Jard. de Genev. 1842. *Herb. DC.*—S. tauricum. "Hedgebank near the Observatory, Cambridge, 1849." *Herb. C. C. Babington* in *Herb. Univ. Cantab.*—S. orientale. Aldborough, Suffolk. Rev. W. Notcutt, 1850. *Herb. Bailey.*—S. tauricum, Willd. Jard. Bot. de Genev. 1872. *Herb. A. Déséglise* in *Herb. DC.*—S. orientale. Railway-bank, Isleworth, Middlesex. R. A. Prior, 1876 (known for five years). *Herb. Mus. Brit.*—S. tauricum. Plantation, Bradfield Combust, Suffolk. W. Jordan, 1876. *Herb. Mus. Brit.*—S. orientale. How Capel, Hereford. A. Ley, 1878. *Herb. C. C. Babington* in *Herb. Univ. Cantab.*—Railway-bank, Richmond, Surrey. G. Nicholson, 1880. *Herb. Bailey.*—Fremington, N. Devon. W. P. Hiern, 1882. *Herb. Mus. Brit.*—Packbrook Grove, Warwickshire. H. Bromwich, 1885. *Herb. H. D. Gray* in *Herb. Univ. Cantab.*—S. tauricum, W., cult. à Saint-Emiland (Saône-et-Loire). Orig. de Russie méridionale. Ch. Ozanon, 1886. *Herb. Cons. Bot. Genev.* and *Bailey.*—S. tauricum, Willd. Coe Fen, Cambridge. I. H. Burkill, 1896. *Herb. J. W. White.*

LIVING PLANTS:—*Cult.* at Sevenoaks. E. M. Holmes, 1911.—Bot. Gard. Cambridge. R. I. Lynch, 1912.—Beech woods, Aberdeen (planted). Dr. O. Darbishire, 1912.

This has been confused with *S. tauricum*, Willd. It greatly resembles that species, but is distinguished by the shortly dentate tubular calyx and the larger flowers. From *S. palæstinum*, Boiss., *S. brachycalyx*, Boiss., and

S. Bornmuelleri, Bucknall, it differs in the larger, thicker, less asperous leaves which are often cordate at the base, and from the first two by the racemose, not dichotomous branching of the stem. De Candolle's var. *β, angustior* belongs partly or entirely to *S. palæstinum*, Boiss.

Linnæus combined this with Tournefort's blue-flowered plant, which probably included more than one species, under the name of *S. orientale*. But Fries was of opinion that the blue-flowered plants which are found in Sweden, and which also contain several distinct forms, are the true *S. orientale*, Linn. As Tournefort's excellent description and figure prove that his *S. constantinopolitanum* is the white-flowered plant which is now accepted as *S. orientale*, Fries was perhaps justified in his opinion, and it would have been better if the name of *S. constantinopolitanum* had been retained for this, and *S. orientale* for one of the blue-flowered species.

13. S. KURDICUM, *Boiss. & Hausskn., in Boiss. Fl. Orient.* iv. p. 174 (1879).

Pallide virens. *Caulis* setis aculeiformibus recurvis parce obsitus, elatus, ramosus. *Folia* membranacea, hirtula et setis tuberculatis aspera, repando-denticulata, ovato-oblonga, longe petiolata, cordata, intermedia et superiora petiolata, obtusiuscula, basi rotundata vel cuneata. *Racemi* fructiferi breves, densiusculi. *Calyx* strigosus, ad medium vel quartam partem superiorem fissus, fructifer ampliatus, accretus, oblongo-campanulatus, ad tertiam partem superiorem in dentes late triangulares, obtusos vel subacutos partitus. *Corolla* late infundibuliformis, alba, calyce duplo longior. *Fornices* staminas vix æquantes. *Antheræ* filamentis breviores. *Nuculæ* supra basin constrictæ, valde obliquæ, subhorizontales, elongatæ, tenuiter venoso-areolatæ, minute tuberculatæ.

"Ex unico specimine fructifero foliis radicalibus orbato descriptum, sed distinctissimum, caulis elatus videtur, folia etiam superiora 3 poll. longa, calyx fructifer ut in *S. palæstino* elongatus, amplus, 6 lineas longus, nuculæ 2 lineas longæ, supra basin horizontaliter curvatæ."—*Boiss.*

Folia radicalia 20 cm. longa, 12 cm. lata ; caulina 9–15 cm. longa, 3·5–7·5 cm. lata ; racemi 7 cm. longi ; flores 22 mm. longi ; calyx 11 mm. longus, fructifer 13 mm. longus ; corolla 20 mm. longa.

GEOGR. DISTR.—TURKEY : KURDISTAN.

SPECIMENS EXAMINED :— Inter Sulimanieh et Sikna et in Pir Omar Gudrum, 1867. *Herb. Boiss.*—In montis Kuh-Sefin. P. Sintenis, No. 1297 (1888). *Herb. Kew.*—In montis Kuh-Sefin, Schaklava, ditionis Erbil. J. Bornmüller, No. 1633 (1893). *Herb. Boiss., Kew.* and *Fielding*.

Nearly related to *S. orientale*, Linn., from which it differs in being more asperous, in the membranaceous leaves, the upper of which are petiolate, not sessile. According to Boissier's description the calyx is divided to the middle when in flower, but in all the specimens I have seen it is divided to one-quarter or scarcely more than one-third. In the plants collected by

P. Sintenis in 1888 the calyx-teeth are triangular, acute, one-third as long as the calyx, and in those collected by Bornmüller in 1893 they are lanceolate, subobtuse, one-quarter to one-third as long as the calyx.

14. S. FLORIBUNDUM, *Shuttlw. in scheda* (1871).

Radix fusiformis, ramosa. *Caulis* validus, elatus, ramosus, pubescens et subtuberculato-pilosus. *Folia* minute tuberculato-hispida, tandem subaspera; inferiora ovata vel oblonga, acuta, basi subcordata vel attenuata, in petiolum decurrentia; media ovata vel ovato-lanceolata, in petiolum brevem marginatum contracta; summa sessilia, in caulem decurrentia. *Racemi* densiflori, demum valde elongati, floribus numerosis. *Rachis* pedicellique calyce breviores pilis sursum curvatis dense hispidi. *Calyx* cylindrico-campanulatus, pubescens, ad tertiam partem in dentes triangulares, acutiusculos fissus. *Corolla* alba, calyce duplo longior. *Fornices* lineari-subulati, obtusiusculi, stamina excedentes. *Antheræ* basi obtusæ, filamentis longiores. *Nuculæ* globosæ, obtusæ, minimæ, abortivæ.

Radix 2–3 dcm. longa; caulis 6–12 dcm. (?) altus; folia radicalia 15–30 cm. longa, 4·5–10 cm. lata; caulina 12 cm. longa, 5·5 cm. lata; flores 18–19 mm. longi; calyx 7 mm. longus; corolla 12–15 mm. longa.

S. mediterraneum, F. Schultz (non Koch) in Arch. de Flore, Journ. Bot Wissembourg (1874); Flora, lviii. (1875) p. 217; Coste, Fl. Fr. ii. p. 582 (1903), *p. p.* Albert & Jahandiez, Cat. Pl. Vasc. Var, p. 341 (1908).

GEOGR. DISTR.—FRANCE: Var.

SPECIMENS EXAMINED:—S. floribundum, Shuttlw. Hyères. Leg. Shuttlw. 1871. *Herb. Kew.*—S. mediterraneum, Koch (F. Schultz). Huet & Shuttleworth, 1872. *Herb. DC.*—S. mediterraneum, Koch non Guss. S. floribundum, Shuttlw. Dans la propriété de Mme. la Comtesse de Beauregard à Hyères (Var, France). Rec. Huet & Shuttleworth, 1872. F. Schultz, herb. norm. nov. ser. Cent. 1, No. 106 and Cent. 4, No. 303. *Herb. Kew.*, *Bailey* and *Bicknell.*—S. mediterraneum, Koch = S. floribundum, Shuttlw. Lieux herbeaux, bord des fossés, Hyères. Leg. Shuttleworth, 1874. *Herb. E. Jahandiez.*—S. floribundum, Shuttlw. Hyères. A. Huet, 1874. *Herb. Boiss.*—Hyères. Le long d'un conduit d'eau dans le jardin même de Chateau Beauregard. Leg. Shuttleworth, 1875. *Herb. Kew.*—S. mediterraneum, Koch. Aups, Var. Lieux humides le long des prairies. H. Hanry, 1881–2. Fl. sel. exsic. no. 351, Ch. Magnier. *Herb. Cons. Bot. Genev.* and *Bailey.*

Judging from herbarium specimens, this species may attain a height of 12 dcm. or more. Its distinguishing characters are the partially decurrent leaves, the dense many-flowered racemes, the short pedicels of the flowers, and the campanulate calyx not divided to the middle.

Shuttleworth described the flowers as yellowish white, but Schultz states that, in plants which he cultivated, they were white. It is remarkable that the plant appears to be always sterile. Schultz only found very small abortive fruits, and in all the specimens which I have seen, some of them well past flowering, the fruits were in the same condition.

I must here give my reasons for concluding that this species, being a branched plant of the *Ramosa* division, cannot be, as Schultz supposed, *S. mediterraneum*, Koch, because, as I hope to prove, the latter is an unbranched plant allied to *S. tuberosum*. Unfortunately, Koch's type cannot be found, and we therefore have to rely on his description, which is as follows :—" *S. mediterraneum* rhizomate . . . . , caule folioso, apice bifido, foliis ovatis, inferioribus in petiolum basi subdilatata amplexicaulem contractis, supremis elliptico-lanceolatis subdecurrentibus, corollis subinfundibuliformi-cylindricis, limbo quinquedentato, dentibus erectis limbo quadruplo brevioribus, antheris filamento duplo longioribus, fornicibus inclusis. Antheræ basi cordatæ ut in omnibus, sed auriculæ in hac specie mucronulatæ. Differt a *S. tuberoso*, foliis caulinis inferioribus cæteris majoribus petiolo basi dilatato amplexicaulibus et summis tantum decurrentibus, corollis dimidio minoribus, dentibus ipsarum erectis et antheris utrinque apiculatis. Radicem et fructum nondum vidi." Koch states that he at first confused this with *S. bulbosum*, Schimp., and as he also compares it with *S. tuberosum*, Linn., it is evident that his plant bore a general resemblance to those species. An analysis of the description will show that it does in fact belong to the *Tuberosa*, and not, like *S. floribundum*, to the *Ramosa*.

Omitting the characters which are common to both groups, and those of the root, which was not represented in Koch's specimen, the points to be noticed are : the stem with bifid apex, which implies that it was otherwise unbranched ; the petiole with dilated and clasping base, which is characteristic of some of the forms of the *Tuberosa*, and is more or less obvious in the lower leaves of *S. tuberosum* itself ; the apiculate base of the anthers, a character which is rarely found in the *Ramosa*, but is always present in the *Tuberosa*. These characters all indicate that Koch's plant belongs to the *Simplicia*, and comparing it with Shuttleworth's plant we see that this differs from it in the strong branched stem, the petioles not dilated and clasping the stem, and the anthers, with obtuse base, scarcely longer than the filaments. Moreover, *S. floribundum* possesses conspicuous characters of its own which Koch could scarcely have overlooked if they had been present in his plant, viz., the very numerous shortly-stalked flowers, and the campanulate calyx divided only to one-third into triangular teeth, forming a characteristic inflorescence very different from that of the plants with which he compares his *S. mediterraneum*.

From these considerations it will, I think, be admitted that the two plants are perfectly distinct, and that I am justified in restoring Shuttleworth's name to his plant.

Although Schultz was, as I believe, mistaken in referring this plant to *S. mediterraneum*, it is to him that we owe a complete and unmistakable description, and a considerable number of the specimens which are found in herbaria.

In his account of the plant he states that Prof. Huet, an industrious collector for the *Herbarium normale*, had searched in vain for *S. mediterraneum*, Koch, in the neighbourhood of Toulon for twelve years. At length, in 1872, Huet sent him the plant which Shuttleworth had found at Hyères, and had named *S. floribundum*.

With specimens for the Herbarium Normale, Huet sent roots which Schultz cultivated, and when the resulting plants flowered he was enabled to draw up a complete description. As no other plant could be found which could be taken for *S. mediterraneum*, Schultz inferred that Shuttleworth's plant was that species, and as the Sicilian plant which Gussone had referred to *S. mediterraneum* was altogether different, he named that *S. Gussonei.*

These three species have always been confused by Italian and French authors. Grenier and Godron give Koch's description with the addition of that of the root of *S. Gussonei*; Coste describes *S. floribundum*, but attributes to it the same kind of root, and Rouy & Foucaud combine the characters and citations of all three species.

It is clear that none of these authors had seen a complete specimen, if any, of *S. floribundum.*

So far as I have been able to ascertain, this plant has not been gathered at Hyères since 1875, and has only been found since at Aups, in 1882, and at Ampus (Albert in Jahandiez' Cat. Pl. du Var). I have not seen a specimen from the latter locality.

15. S. PSEUDOBULBOSUM, *Aznavour in Bull. Herb. Boiss.* sér. II. iii. p. 588 (1903).

Radix fusiformis, crassa, carnosa. *Caulis* pubescens et setis albis sæpius e tuberculo ortis patentim hirsutus, procerus, valde ramosus, angulatus, inferne propter folia longe decurrentia anguste alatus. *Folia* puberula et setosa, inferiora parva, ovato-oblonga, interdum basi subcordata, media majora, oblongo-lanceolata, in petiolum alatum attenuata aut contracta, superiora decrescentia, ovato-oblonga, sessilia, non vel breviter decurrentia, summa basi rotundata vel breviter cuneata, omnia acuta. *Racemi* multiflori, demum laxiusculi. *Rachis* pedicellique pilis uncinatis et sursum curvatis obsiti. *Calyx* fere ad medium in dentes triangulari-lanceolatos acutiusculos partitus, fructifer parum accrescens, campanulatus, deflexus. *Corolla* ochroleuca, calyce duplo longior. *Fornices* late triangulari-lanceolati, acutiusculi, breviter exserti. *Antheræ* filamenta æquantes vel fere duplo excedentes. *Nuculæ* parvæ, supra basin constrictæ, obtusæ, venoso-areolatæ, minuteque tuberculatæ.

Caulis 7–12 dcm. altus ; folia media 12·5–16 cm. longa, 5–7·5 cm. lata ; flores 10–12 mm. longi ; calyx 6–7 mm. longus, fructifer 9 mm. longus ; corolla 9–11 mm. longa ; nuculæ 2 mm. longæ.

GEOGR. DISTR.—TURKEY : Asiatic side of the Bosphorus in shady places.

SPECIMENS EXAMINED :—Beikos, Constantinople. Leg. Aznavour, 1892, 1894, 1902. *Herb. Bailey.*—1902, 1904. *Herb. S. Lond. Bot. Inst.*

This, the most recently discovered species of the genus, is well characterised by the stem being narrowly winged below, by the small white corolla with its scales shortly exserted, and by the calyx being divided scarcely to the middle. It is easily distinguished from *S. ottomanum*, Friv., which is a shorter, more slender plant, with denser, longer hairs, smaller leaves, deeply divided calyx, and longer corolla-scales.

16. S. PALÆSTINUM, *Boiss.*, *Diagn.* ser. I. xi. p. 94 (1844).

Pallide virens, brevissime pubescenti-viscidum. *Radix* fusiformis, simplex vel ramosa. *Caulis* setis tuberculatis curvatis parce obsitus, subdichotome ramosus, petiolorum decurrentiâ angulatus. *Folia* repanda, tuberculato-setosa, inferiora ovata vel oblonga, obtusa, basi cordata, rotundata vel attenuata, petiolis ad basin marginatis, superiora breviter petiolata, summa sessilia. *Racemi* fructiferi vix laxi. *Rachis* pedicellique setis longis curvatis et pubescentiâ uncinatâ obsiti. *Calyx* parce tuberculato-setosus, campanulatus, ad tertiam vel quartam partem in dentes lineari-subulatos obtusiusculos longe ciliatos partitus, fructifer valde accretus, dentibus triangularibus. *Corolla* alba, calyce duplo longior. *Fornices* stamina æquantes. *Antheræ* filamentis sublongiores. *Nuculæ* rectiusculæ, angustæ, leviter constrictæ, venoso-areolatæ, venis lævibus, minute tuberculatæ.

Caulis 2–4 dcm. vel ultra altus ; folia 6–10 cm. longa, 3–6 cm. lata ; flores 10–15 mm. longi ; calyx 7–8 mm., fructifer 12–14 mm. longus ; corolla 11–13 mm. longa ; nuculæ 3 mm. longæ, 1·5 mm. latæ.

S. palæstinum, Boiss. Fl. Orient. iv. p. 173 (1879) ; *S. Palæstinæ*, Walp. Ann. iii. 127 ; *S. orientale β. angustior*, DC. Prod. x. p. 39 (1846), *p.p.*

GEOGR. DISTR.—TURKEY : Palestine, Syria, Southern Asia Minor.

SPECIMENS EXAMINED :—S. sp. Rainade, El Kenite, Antilibanus. C. Gaillardot, no. 2072, 1817. *Herb. Kew* and *Boiss.*—S. orientale β. angustior, DC. In monte Tauro. Aucher-Eloy, Herbier d'Orient, no. 2351, 1836 or 1837. *Herb. Kew.* and *Mus. Brit.*—S. asperrimum. In monte Tauro. Aucher-Eloy, 1837. *Herb. DC.* and *Kew.*—S. anatolicum, Boiss. Solyma, Pamphylia. *Herb. de Dr. Heldreich*, 1845. *Herb. Mus. Brit.*, *Univ. Cantab.*, and *Fielding.*—S. palæstinum, Boiss. Antilibanus, Syria ; Jerusalem, Palestine. E. Boissier, 1846.—*Herb. Kew.* and *Univ. Cantab.* Rascheya, Syria. E. Boissier, 1846. *Herb. Boiss.*—Jerusalem. Th. Kotschy, no. 446, 1855. *Herb. Kew.* and *Mus. Brit.*—Rascheya. Th. Kotschy, no. 774. *Herb.*

Boiss.—Jerusalem. Dr. Roth, 1860. *Herb. Kew.*—S. orientale, Linn. Tibney Bashan. B. T. Lowne, 1863–4. *Herb. Kew.*, *Fielding*, and *Univ. Cantab.*—S. palæstinum, Boiss. East of Jordan. J. A. Paine, 1873. *Herb. Kew.*—Tom Niha (Tau' amat. ?), Monte Libano. J. Ball, 1877. *Herb. Kew.*—Between Hasbeiya and Rascheya. Ex herb. Postian., 1877. *Herb. Kew.*—Reservoirs de Salomon, Palestine. W. Barbey, 1880. *Herb. DC.*—Es Salt (Ramoth Gilead). Ex herb. Postian, 1886. *Herb. Mus. Brit.* —Safed, N. Galilee. Bornmüller, no. 1138, 1897. *Herb. Boiss.*

Var. DENTATUM, *Boiss.* *Folia* acute denticulata.

Hab. "in Lyciâ prope Kourmala ad occidentem urbis Adalia et in Monte Solyma."

Boiss. Fl. Orient. iv. p. 173.

SPECIMEN EXAMINED: *S. palæstinum* var. *dentatum.* Kourmala, 1875 *Herb. Boissier.*

Var. MAJUS, var. nov. *Folia* membranacea, ampla in petiolum sensim attenuata.

Caulis 5 dcm. altus ; folia ad 17 cm. longa, 7·5 cm. lata ; flores 16 mm. longi ; calyx 8 mm. longus.

HAB. TURKEY : Cilicia.

SPECIMENS EXAMINED :—S. palæstinum, Boiss. Cilicia. W. Siehe, No. 55, 1896. *Herb. Kew.*, *Mus. Brit.*, and *Fielding.*

S. palæstinum forms, with *S. brachycalyx* and *S. Bornmuelleri*, a group of closely allied species. These must be carefully distinguished from each other, but are, nevertheless, separated by well defined characters, and occupy areas which do not overlap. From *S. brachycalyx*, *S. palæstinum* differs in the lower leaves being more often rounded or subcordate at the base, although they are sometimes attenuated into the petiole as in that species, and in the calyx, which is much more accrescent in fruit. From *S. Bornmuelleri* it is easily distinguished, even in a young stage, by the subdichotomous branching of the stem, and by the more deeply divided calyx with linear or triangular teeth, which are generally one-third as long as the calyx itself. In 'Flora Orientalis' Boissier states that the leaves are not truly decurrent, but that the petioles are produced into the angles of the stem ; this is not easily detected in the dry plant. In the 'Diagnoses,' however, he describes the upper leaves as shortly decurrent, and this is seen to be the case in Boissier's own specimens.

The area of *S. palæstinum* extends further south than that of any known species ; commencing in the neighbourhood of Jerusalem, it includes a zone passing through Syria round the eastern shores of the Mediterrranean, and along the Taurus range through Cilicia to Lycia.

Siehe's Cilician plant No. 55 being in a young stage of growth, it is not possible to determine its position with certainty. It is a distinct looking plant and its area is within that of *S. palæstinum.* I have therefore named it provisionally as a variety of that species, but fruiting specimens with mature calyces might prove it to be entitled to higher rank than this. All the specimens cited, as well as others contained in the Geneva herbaria, appear to belong to the same gathering.

17. S. BRACHYCALYX, *Boiss., Diagn.* ser. I. iv. p. 43 (1844).

Viride, pubescens. *Caulis* pilis mollibus longis patentibus vel deflexis obsitus, gracilis, subdichotome paniculato-corymbosus. *Folia* pilis minute tuberculatis breviter hirsuta, tenera, subrepanda, inferiora oblonga, in petiolum ad basin marginatum attenuata, superiora lanceolata, sessilia. *Racemi* tandem laxi. *Rachis* pedicellique longe pilosi. *Calyx* pilis tenuibus vestitus, ad tertiam partem in dentes triangulari-lanceolatos obtusiusculos fissus, fructifer parum auctus, breviter campanulatus deflexus. *Corolla* alba, calyce duplo triplove longior. *Fornices* obtusi, stamina vix æquantes vel paullo superantes. *Antheræ* filamentis sesquibreviores. *Nuculæ* supra basin constrictæ, valde venoso-areolatæ, venis lævibus, minute tuberculatæ.

Caulis 3–5 dcm. altus; folia inferiora 5–7 cm. longa, 2·5–3 cm. lata; flores 14 mm. longi, calyx 7 mm. longus, fructifer 7–8 mm. longus; corolla 13 mm. longa; nuculæ 2·5 mm. longæ, 1·2 mm. latæ.

S. brachycalyx, Boiss. Fl. Orient. iv. p. 173 (1879); DC. Prod. x. p. 39 (1846).

GEOGR. DISTR.—TURKEY : Caria.

SPECIMENS EXAMINED :—S. orientale, Pinard non Linn. "In Cariæ montibus." C. Pinard, 1843. *Herb. Kew., Univ. Cantab., Fielding, D.C.,* and *Boiss.*

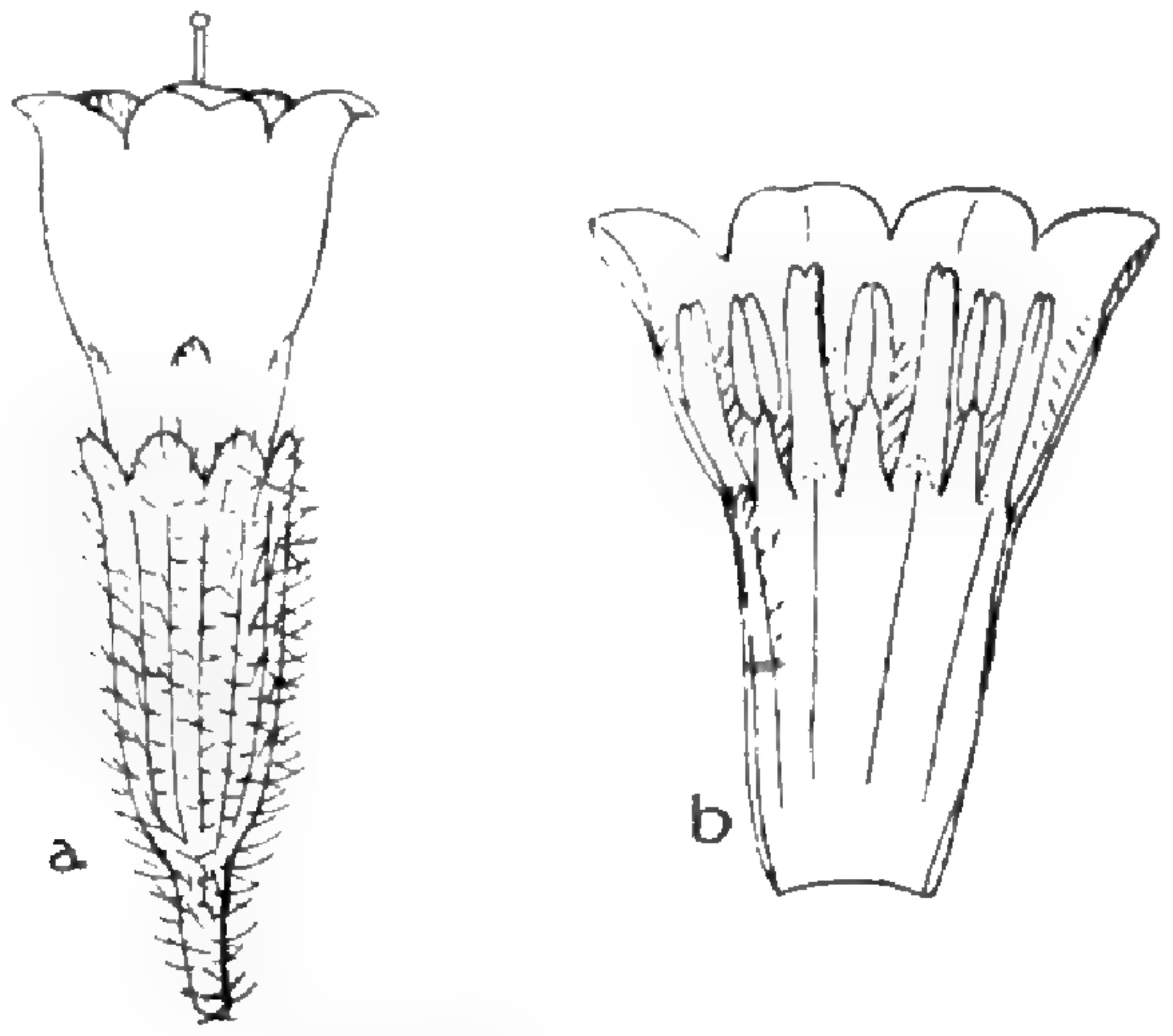
The distinguishing characters of this species are the leaves gradually attenuated into the petiole and the campanulate calyx only slightly enlarged in fruit. From *S. Bornmuelleri* it differs in the dichotomous branching of the stem and the more deeply divided, campanulate, not cylindrical calyx.

It is doubtful whether this has been found outside the ancient province of Caria, in the south-west corner of Asia Minor. All other plants referred to it are *S. palæstinum* or *S. Bornmuelleri.*

18. S. BORNMUELLERI, sp. nov.

Radix subcylindrica, radiculas crassiusculas edens. *Caulis* gracilis, racemoso-ramosus, sursum paniculato-corymbosus, tenuiter breviterque pilosus et parce tuberculato-setosus. *Folia* tenera, setis minutis subaspera, inferiora oblonga vel ovato-lanceolata, basi cordata, rotundata vel cuneata, in petiolum subæquilongum alatum decurrentia, media in petiolum late marginatum attenuata, superiora ovata, sessilia, subdecurrentia. *Racemi* parvi, fructiferi elongati. *Rachis* pedicellique puberuli et breviter pilosi. *Calyx* tubulosus, ad sextam partem in dentes breves ovatos obtusos partitus, fructifer auctus, subglabrescens. *Corolla* alba, calyce duplo longior. *Fornices* obtusi, stamina paullo excedentes. Antheræ obtusæ, filamentis dimidio longiores. *Nuculæ* rectiusculæ, venoso-areolatæ, venis fere lævibus, areolis minute tuberculatis.

Fig. 2.



Symphytum Bornmuelleri.
a. Flower. *b.* Corolla opened to show stamens and corolla-scales. × 2.

Caulis 2–4·5 dcm. altus ; folia inferiora 6–8 cm. longa, 2–4·4 cm. lata ; racemus fructifer ad 7·5 cm. longus ; flores 17 mm. longi, calyx 8–9 mm. longus, fructifer 10–12 mm. longus, 5 mm. latus ; nuculæ 3 mm. longæ, 1·5 mm. latæ.

S. brachycalyx, Haussknecht non Boiss., Pl. exsic. Anatoliæ Orient. 761, and Pont. Galaticus, No. 2107 (?).

GEOGR. DISTR.—TURKEY : Northern Asia Minor.

SPECIMENS EXAMINED :—“S. brachycalyx Boiss.” Ak-Dagh, Amasia. Bornmüller, No. 761, 1889. *Herb. Kew* and *Mus. Brit.*—Sanadagh, Pontus Galaticus. Bornmüller, No. 2107 (?) 1890. *Herb. Kew.*, *Mus. Brit.*, *Fielding*, and *Bailey*.

This species, having been determined as *S. brachycalyx*, Boiss., by Haussknecht, occasioned much uncertainty in my mind with regard to the limits of variation, both in that species and in *S. palæstinum*, Boiss., until, by careful comparison of authentic specimens, I realized that Bornmüller's plant could not be assigned to either of these. Boissier's description of the stem of *S. brachycalyx* is, in the ‘Diagnoses,’ “caulibus a basi ramosis,” and in ‘Flora Orientalis,’ caulibus subdichotome paniculato-corymbosis.” In actual specimens the stem is generally forked, with the branches comparable in size with the main stem. In *S. Bornmuelleri* the branches are arranged in a racemose manner in the axils of leaves and are small in comparison with the stem, and

it is only at the top of mature plants that they are corymbose. The calyx also is very different from that of *S. brachycalyx*, which Boissier describes in the 'Diagnoses,' as "breviter campanulato laciniis triangulari-lanceolatis obtusiusculis tubo calycino brevioribus," and in 'Flora Orientalis,' "calyce fructifero parum aucto breviter campanulato ad tertiam partem in dentes triangulares fisso." In *S. Bornmuelleri* it is tubular, cylindric, much enlarged in fruit, with broadly ovate, obtuse teeth, which are scarcely one sixth of the length of the tube—shorter in proportion than in any other described species. From *S. palæstinum* it differs in the same way, but in that species the calyx is still more enlarged in fruit. It also differs from both in being very shortly and sparingly pilose.

Having only been found in the north of Asia Minor, its area is, as far as is known, quite distinct from those of the related species, being about 200 miles distant from that of *S. palæstinum* and 600 from that of *S. brachycalyx*.

19. S. TUBEROSUM, *Linn.*, *Sp. Pl.* ed. I. p. 136 (1753).

Radix obliqua, ramosa, tuberoso-incrassata, nodosa. *Caulis* retrorsum setosus, simplex, raro parce ramosus, sæpe apice bifidus. *Folia* puberula et magis minusve dense hispida, inferiora parva, ovata vel spathulata, in petiolum alatum, basi subdilatatum, amplexicaulem contracta vel attenuata, media majora, ovato-lanceolata vel elliptica, in petiolum attenuata, summa sessilia, subdecurrentia. *Racemi* pauciflori. *Rachis* pedicellique pubescentes parceque pilosa. *Calyx* ad quartam partem inferiorem in lacinias lanceolatas acutas pubescentes longe ciliatas fissus. *Corolla* ochroleuca, calycem duplo triplove excedens. *Fornices* inclusi, late triangulari-subulati, acuminati, stamina dimidium superantes. *Antheræ* basi apiculatæ, filamenta duplo excedentes. *Nuculæ* late ovatæ, leviter curvatæ, supra basin constrictæ, obtusæ, debiliter rugoso-areolatæ, minute tuberculatæ.

Caulis 2–5 dcm. altus ; folia caulina media 10–14 cm. longa, 3·5–6 cm. lata ; flores 15–18 mm. longi ; calyx 7–8 mm. longus ; corolla 12–16 mm. longa ; nuculæ 3·5 mm. longæ, 3 mm. latæ.

S. tuberosum, Lobel, Stirp. Hist. p. 315, with figure (1576).

Symphytum sp., Gerard, Herball, p. 661 (1597).

S. tuberosum majus, Clusius, Hist. lib. 5. p. clxvi (1601).

S. majus tuberosa radice, C. Bauhin, Pinax, p. 259 (1623).

S. tuberosum, Gerard, Herball emend. p. 806 (1633).

S. tuberosum, Linn., Jacq. Obs. pars 3, p. 12, t. 63 (1768) ; Jacq. Fl. Austr. t. 225 (1773–78) ; Lightf. Fl. Scot. p. 1092 (1777) ; With. Bot. Arr. ed. 2, p. 196 (1787) ; Huds. Fl. Angl. ed. 2, p. 648 (1798) ; Smith, Fl. Brit. p. 219 (1800) ; Smith, Eng. Bot. t. 1502 (1805) ; Lehm. Asperif. no. 253 (1818) ; Reich. Icon. xviii. t. 103 (1857) ; Dietr., Fl. Boruss. t. 675 (1842); DC. Prod. x. p. 38 (1846); Ledeb. Fl. Ross. iii. p. 115 (1846–51); Gren. & Godr. Fl. Fr. ii. p. 511 (1850); Syme, Eng. Bot. t. 1517 (1867).

S. foliosum, Rehm. Verh. zool.-bot. Ges. Wien, xviii. p. 495 (1868).

S. tuberosum, Linn., Willk. & Lange, Fl. Hisp. ii. p. 492 (1870); Caruel in Parl. Fl. Ital. vi. p. 879 (1884); Coste, Fl. Fr. ii. p. 582 (1903).

GEOGR. DISTR.—From BRITAIN, FRANCE and SPAIN to TURKEY, and from GERMANY and S.W. RUSSIA to ITALY and GREECE.

SPECIMENS EXAMINED:—BRITAIN: S. tuberosum radice. Chelsea Garden, 1747. *Herb. Mus. Brit.*—S. tuberosum, Linn. Edinburgh Garden, 1782. *Herb. Smith* in *Herb. Soc. Linn.*—Leith Water, Edinburgh. R. B. 1794. *Herb. Mus. Brit.*—Thunbridge near Ware, Herts, 1874, "with *Tulipa sylvestris.* Truly wild." *Herb. Mus. Brit.*—Walton Bridge, Middlesex. H. & J. G[roves], 1877. "Common." *Herb. Mus. Brit.*—Stoke Bishop Wood, near Bristol, 1890. *Herb. J. W. White.*—Llanberis, Carnarvon. E. S. & C. E. Salmon, 1891. *Herb. Mus. Brit.* and *C. E. Salmon.*

THE CONTINENT.—S. tuberosum, Linn. Bayonne, France. Endress, 1831. *Herb. Kew.*—Levey, St. Maurice, Valais. *Herb. Cons. Bot. Genev.*—Matrit. (Madrid) in umbrosis Real Casa del Campo. Reuter, 1841. *Herb. Kew.* and *Cons. Bot. Genev.*—Constantinople. Aucher-Eloy, Herb. d'Orient, 2370. *Herb. Kew.*—Baku, Caucasus. Leg. Becker, 1876.—S. ottomanum. "In agro Byzantino." Leg. Noe, 1876 (?) *Herb. Kew.*—S. tuberosum, Linn. Bordighera, 1888–1896. *Herb. C. Bicknell.*—Rome. Baenitz, 1895. *Herb. Bailey.*—S. foliosum, Rehm. Czernelica, Galicia, Austria. F. A. Knapp, 1895–6. *Herb. Bicknell.*—S. tuberosum, Linn. Lugano, Switzerland. Hans Schinz, 1896. *Herb. Bicknell.*—S. ottomanum, Friv. Kratilsvica, Servia, 1897. *Herb. Kew.*—Hyères, France, 1892. Leg. C. Bucknall.—Murau, Styria, 1907.—Belvidere, Montenegro. Leg. Bierbach. *Herb. Cons. Bot. Genev.*

Var. ANGUSTIFOLIUM, *Kern. in Oester. Bot. Zeitschr.* xiii. (1863) p. 227, *pro sp.*—*Caulis* ramosus, tuberculato-setosus. *Folia* oblongo-linearia vel oblongo-lanceolata, basin versus attenuata et angustissime decurrentia. *Calyx* in lacinias lineares fissus. *Corolla* calycem duplo excedens.

Caulis 3–4·5 dem. altus; folia caulina 7·5–12·5 cm. longa, 1·3–2·5 cm. lata; sepala 6 mm. longa, 1 mm. lata; corolla 12 mm. longa.

SPECIMENS EXAMINED:—S. tuberosum forma. Dubienko pr. Monasterzyska, Galicia orient.-austr. Br. Blocki, 1894. *Herb. Mus. Brit.*—Casovia, Hungaria septr. *cult.* E. Woloszczak. Fl. Polon. Exsic. No. 851, 1902. *Herb. Mus. Brit.*

S. tuberosum is distinguished from allied species by the thick, branched, tuberous root, by the lower leaves which are smaller than the succeeding ones, and by the included stamens.

The var. *angustifolium*, Kern. is a very distinct looking plant, of which I have only seen the specimens cited. In these the primordial leaves are very small and narrow, measuring with the petiole 3 cm. × 0·3 cm.; the largest stem-leaves are 10 cm. × 1·4 cm., the flowers 15 mm. long, the calyx 8 mm. long, with nearly filiform segments only 0·5 mm. wide at the base. In Dr. Woloszczak's plants, cultivated at Kaschau, the leaves are rather broader in proportion to their length. The Trencsin plants referred to *S. angustifolium* have small leaves which are mostly similar in shape and proportions to those of typical *S. tuberosum*, but in some cases they show a tendency to become more elongated. These cannot be regarded as representing Kerner's plant.

S. foliosum, Rehm. differs from *S. tuberosum*, according to the description, in the radical leaves being very numerous, and in the corolla being twice as broad. Specimens from woods on the banks of the Dniester at Czernelica, the *locus classicus*, are nearly past flowering, and therefore not in a condition to show any distinctive characters which they may have possessed. The stem is about 3·5 dcm. high, nearly naked for more than half its length with leaves crowded towards the top, and the few remaining flowers are small. Otherwise there is nothing to distinguish these specimens from *S. tuberosum*.

The plants of the *Tuberosum* section are more nearly related than those of most of the other sections of the genus, and opinions have differed greatly as to their rank. Caruel states that, having studied these plants in the neighbourhood of Florence, where all the forms grow promiscuously together, he has formed the opinion (Fl. Ital. vi. p. 879) that *S. mediterraneum*, *Gussonei*, *bulbosum*, and *Zeyheri* are all different forms or states of *S. tuberosum*, and that this species varies in the following manner:—The root is thickened in different ways, sometimes for a considerable distance as in Reich. Icon. t. 103, sometimes becoming large and nodose as in Jacq. t. 63, and sometimes it is thickened at intervals into lateral, sessile or stipitate tubercles as in Bischoff's figure of *S. filipendulum* (*S. bulbosum*, Schimp.) in 'Flora,' ix. p. 561; the flowers vary in size, sometimes the entire flower, sometimes only the corolla being smaller, and in the latter case the corolla-scales and style are necessarily exserted.

But it should be borne in mind, firstly, that where *S. tuberosum* and *S. bulbosum* grow together, the circumstances are not favourable for forming an opinion as to the relationship of the members of this group, on account of the probability of hybridization taking place between them and producing a series of forms which may be confused with independent species. Secondly, that other characters must be taken into consideration besides those of the root and flowers on which Caruel relies. Thirdly, that so far as is known, the plants mentioned above do not appear to be hybrids, but stable forms occupying separate geographical areas. In the case of *S. tuberosum* and

S. bulbosum the areas are partly distinct and partly overlapping ; that of *S mediterraneum* is within the area of *S. tuberosum*, and just outside that of *S. bulbosum* ; *S. Gussonei* and *S. Zeyheri* are within the area of *S. bulbosum*, and outside that of *S. tuberosum*.

After much consideration and careful comparison of numerous specimens, I have decided to treat these plants as species, in accordance with the views of those authors who, having studied them in their natural habitats, or in other ways, have had the opportunity of forming a definite opinion, have arrived at the conclusion that they are distinct entities, and not chance variations of a single species.

20. S. MEDITERRANEUM, *Koch, Syn. Fl. Germ.* ed. 1, p. 500 (1837), *non Schultz, nec Guss.*

Radix . . . . *Caulis* simplex vel apice bifidus, interdum (vel semper ?) flexuosus, retrorsum piloso-hirsutus. *Folia* setoso-pilosa, setis interdum minute tuberculatis, inferiora late ovata, basi subcordata vel rotundata, cæteris majora vel saltem latiora, in petiolum late marginatum basi subdilatatum, amplexicaulem contracta, media ovata vel ovato-lanceolata, in petiolum contracta vel attenuata, suprema sessilia, subdecurrentia. *Racemi* pauciflori. *Rachis* et pedicelli pubescentes breviterque pilosi. *Calyx* pubescens, ultra tertiam partem inferiorem in lacinias lineari-lanceolatas ciliatas fissus. *Corolla* ochroleuca, calycem subduplo excedens. *Fornices* lanceolati, acuminati, stamina longe excedentes. *Antheræ* basi apiculatæ, filamenta triplo excedentes. *Nuculæ* . . . .

Caulis (in spec. visis) 1·5 dcm. altus ; folia infima 4·5 cm. longa, 3·5 cm. lata, caulina inferiora 6–7 cm. longa, 2–3 cm. lata ; flores 15–18 mm. longi, calyx 7 mm. longus.

S. mediterraneum, Koch, Gren. & Godr. Fl. Fr. ii. p. 512 (1850), *partim.*

GEOGR. DISTR.—FRANCE : Var ; Bouches du Rhône ; Alpes Maritimes (?).

SPECIMENS EXAMINED :—Aubagne, Bouches du Rhône. Herb. J. S. Mill, 1872. *Herb. Kew.*—Aubagne "in Provence," March. *Herb. Bailey.*—(?) Near the pottery of Clement Massier, Vallauris, Alp. Mar. Miss Maud Law, 1882. *Herb. Bailey.*

In Koch's type specimen, which cannot now be found, the root was wanting ; but Italian and French authors have attributed to it a root similar to that of *S. bulbosum*, viz. slender and creeping, with tubercles at intervals, because *S. mediterraneum*, Gussone (*S. Gussonei*, Schultz), has such a root.

The comparison of plants named *S. mediterraneum*, Koch, from Aubagne with authentic Sicilian specimens of *S. Gussonei*, Schultz, which I had tried in vain to reconcile with each other and with descriptions, shows that there are two distinct forms, allied to *S. tuberosum*, Linn., but varying from it in

different directions, and occupying different areas. The Aubagne plants, of which there is a good sheet at Kew, all, unfortunately, without roots, at first appeared to me to be young specimens of *S. tuberosum*, but, on comparing them with plants of that species in the same stage of growth, I found that they were not only very different in habit, but possessed in a marked degree the characters which Koch gives as distinguishing *S. mediterraneum*. As the locality, Aubagne, is only twenty miles or so from Toulon, in the neighbourhood of which town Koch's plant was found, there is every reason for the belief that this is at least a form of *S. mediterraneum*.

The Aubagne plants are distinguished from *S. tuberosum* by the lower and more compact growth, by the flexuous stem which is bent in alternate directions at each node, and by the comparatively large cordate or rounded lower leaves which are broader than, but not so long as, the succeeding ones. The size of the flowers is only a little less than is usual in *S. tuberosum*, and in this point the Aubagne plants do not correspond with Koch's statement that they are only half the size of those of that species. This has been copied by succeeding authors as a character of *S. mediterraneum*, but, as the size of the flower is often variable in this genus, this need not be an obstacle to the acceptance of these plants as Koch's species. The winged amplexicaul petioles form a well-marked feature of the Aubagne plants, and in this Koch states that *S. mediterraneum* differs from *S. tuberosum*. This character is, however, also found in the latter species, as well as in other members of the group, more especially in the primordial leaves, but it is not generally so conspicuous as in *S. mediterraneum*.

The plant gathered by Miss Maud Law at Vallauris, which is about 100 miles from Aubagne, differs in the lower leaves being gradually attenuated into the petiole, and in the taller and straighter stem. It may be regarded as intermediate between *S. tuberosum* and *S. mediterraneum*.

21. S. GUSSONEI, *Schultz, in Arch. Fl.* (1874) p. lviii.

Radix repens, gracilis, teres, tubercula subrotunda invicem gerens. *Caulis* simplex vel apice bifidus, gracilis, parce retrorsum pilosus. *Folia* pilosa, infima minima, lanceolata vel elliptica, in petiolum anguste alatum, basi amplexicaulem attenuata, media multo majora, ovata, elliptica vel oblonga, in petiolum brevem, late alatum subattenuata, suprema ovata, sessilia. *Racemi* pauciflori. *Rachis* pedicellique pubescentes et parce pilosi. *Calyx* ad tertiam partem inferiorem in lacinias lanceolatas acutas ciliatas fissus. *Corolla* albida, calycem subtriplo excedens. *Fornices* lanceolati, acuti, inclusi, stamina longe excedentes. *Antheræ* basi apiculatæ, filamentis subduplo longiores. *Nuculæ* . . . .

Tubercula 1–2 cm. et ultra diam.; caulis 2–3 dcm. altus; folia infima 1·5 2 cm. longa, 0·8–1·5 cm. lata, media 8–9 cm. longa, 3·5 cm. lata, vel

5–7 cm. longa, 2·4 cm. lata; flores 15–20 mm. longi; calyx 6–7 mm. longus; corolla 15–18 mm. longa.

S. mediterraneum, Gussone, Fl. Sic. ii. p. 792 (1844) non Koch.
? *S. nodosum*, Schur, Enum. Transs. p. 468 (1866).
S. Gussonei, Schultz, Flora, lviii. p. 218 (1875).
S. tuberosum forma, Caruel in Parl. Fl. Ital. vi. p. 879 (1884).
S. Gussonei, Schultz, Lojacono Pojero, Fl. Sic. p. 66 (1902).

GEOGR. DISTR.—SICILY. GALICIA.

SPECIMENS EXAMINED:—S. mediterraneum, Koch. Mirto, Sicily. Todaro exsic. 1393. *Herb. Kew.*, *Univ. Cantab.*, and *Bailey*.—S. Gussonei, Schultz, prope Messinam, Sicilia. Leg. Nicotra, 1879. F. Schultz, Herb. norm. 2373. *Herb. Fielding.*—Gurgo prope Gibilmanna. M. Lojacono Pojero, Pl. Ital. Sel. cent. iii. No. 225, 1887. *Herb. Kew.*, *Mus. Brit.*, *Univ. Cantab.*, *S. Lond. Bot. Inst.*, and *Bailey*.—S. Gussonei, Nym. Castelbuono, Sicilia. M. Lojacono Pojero. *Herb. Bicknell.*—? S. nodosum, Schur. Skole, Galicia Orient. Dr. Woloszczak, 1897.

The creeping root, which is like that of *S. bulbosum* and *S. Zeyheri*, alone distinguishes this from *S. tuberosum*.

From *S. mediterraneum* it differs in the lower leaves being smaller than the succeeding ones, and from *S. bulbosum* and *S. Zeyheri* in the included corolla-scales. Lojacono describes it as a small plant with the lower leaves appressed to the ground, and few stem-leaves. He also states that the root is that of *S. officinale*, but, in any case, this must be an error. His plant is probably a small form of *S. Gussonei.*

S. nodosum, Schur, is a plant 16–20 cm. high, growing in rock-fissures at Surul, Götzenburg, Transylvania. It resembles *S. tuberosum* except in the root, which is like that of *S. bulbosum*. Schur remarks "An var. rupestris S. tuberosi insignis?" It is remarkable that plants apparently so similar as this and *S. Gussonei* should occur in such different and widely separated localities as the lowlands of Sicily and the rocks of the Transylvanian mountains. More complete examples are necessary in order to form an opinion as to the position of Schur's plant. Dr. Woloszczak's plant named *S. nodosum* from Skole is like *S. tuberosum*, but the root is wanting.

22. S. BULBOSUM, *Schimp. in Flora*, viii. (1825) p. 17.

Radix repens, gracilis, teres, elongata, tubera subrotunda invicem gerens. *Caulis* simplex vel apicem bifidus, raro subramosus, subglaber vel retrorsim setosus. *Folia* minute parceque setosa, inferiora ovata vel spathulata cum mediis majoribus ovato-oblongis in petiolum alatum basi subdilatatum, amplexicaulem contracta vel attenuata, superiora sessilia, subdecurrentia. *Racemi* pauciflori. *Rachis* pedicellique dense pubescentes, pilis longis perpaucis obsiti. *Calyx* pubescens, ad tertiam partem inferiorem in laciniis lanceolatas

subacutas longe ciliatis fissus. *Corolla* ochroleuca, subcylindrica, calycem subduplo excedens, in dentes ovatos breves erectos fissa. *Fornices* lanceolato-subulati, ad apicem obtusiusculum attenuati, longe exserti. *Antheræ* basi subapiculatæ, filamenta paullum excedentes. *Nuculæ* late ovatæ, subcurvatæ, supra basin constrictæ, obsolete reticulato-rugosæ, minute albido-tuberculatæ.

Caulis 2–4 dcm. altus ; folia caulina 7–17 cm. longa, 3–9 cm. lata ; flores (cum fornicibus) 13–15 mm. longi ; calyx 5 mm. longus ; corolla 9–11 mm. longa ; nuculæ 3 mm. longæ, 3 mm. latæ.

S. tuberosum minus, Clusius, Stirp. Pann. Hist. p. 671 with figure (1583) ; Clus. Hist. lib. 5, p. clxvi (1601).

S. minus tuberosa radice, C. Bauhin, Pinax, p. 259 (1623).

S. bulbosum, Schimp. ; Reich., Pl. crit. cent. 3, t. ccxx. fig. 367 (1825).

S. filipendulum, Bischoff in Flora, ix. (1826) p. 561.

S. Clusii, Gmel. Fl. Bad. iv. p. 144 (1826).

S. punctatum, Gaud. Fl. Helv. ii. p. 41 (1828).

S. tuberosum β. exsertum, Loisel, Fl. Gall. ed. 2, i. p. 152 (1828).

S. macrolepis, Gay in Reich. Fl. Exc. i. p. 347 (1832).

S. bulbosum, Schimp. ; Koch, Syn. Fl. Germ. ed. 1, p. 500 (1837); DC. Prod. x. p. 38 (1846) ; Gren. & Godr. Fl. Fr. ii. p. 512 (1850) ; Reich. Icon. Fl. Germ. t. 104. fig. 2 (1857).

S. tuberosum β. Clusii, Caruel in Parl. Fl. Ital. vi. p. 879 (1884).

S. bulbosum, Schimp. ; Coste, Fl. Fr. ii. p. 582 (1903) ; Rouy & Fouc. Fl. Fr. x. p. 291 (1908).

GEOGR. DISTR.—From GERMANY (native ?) and SWITZERLAND to SICILY and GREECE, and from S.E. FRANCE to BULGARIA.

SPECIMENS EXAMINED :—S. tuberosum. S. Europe. Yalden. *Herb. Banks* in *Herb. Mus. Brit.*—S. bulbosum, Schimp. Heidelberg. Schultz, 1836. *Herb. Cons. Bot. Gener.*—Calabria. Prof. Gasparini, 1839. *Herb. Univ. Cantab.*—Monte Generoso, Switzerland, ex *Herb. Boiss. Herb. Kew.*—Sorrento, Italy. Townsend, 1860. *Herb. S. Lond. Bot. Inst.*—Cardo, Corsica. P. Mabille, Herb. Cors. No. 225, 1867. *Herb. Univ. Cantab.*—Bastia, Corsica. Gaston Genevier, 1869. *Herb. Univ. Cantab.*—Weissenburg, Alsace. Rec. F. Schultz. Herb. Norm. 110, 1871. *Herb. Univ. Cantab.* and *Fielding.*—S. macrolepis, Gay. In Weinbergen, Heidelberg. *Herb. Univ. Cantab.*—S. bulbosum, Schimp. Tatoe, Greece. W. Barbey, 1873. *Herb. Cons. Bot. Genev.*—Mentone. André, 1882. *Herb. Bicknell.*—Bordighera. C. Bicknell, 1887–1896. *Herb. Bicknell.* — Weissenburg, Alsace. Hausser, 1893. *Herb. S. Lond. Bot. Inst.*—Volo, Greece. P. Sintensis, 1896. *Herb. Cons. Bot. Genev.*, *Bicknell*, and *Bailey.*—Rome. R. Pirotta, 1897. *Herb. Cons. Bot. Genev.*, *S. Lond. Bot. Inst.*, and *Bailey.*—Solduno, near Locarno, 1897. *Herb. Bicknell.*—S. ottomanum.

Voden, Macedonia. Adamovic, 1903. *Herb. Kew.*—S. tuberosum. Camaldoli, Naples. M. Guadano, 1904. *Herb. Bicknell.*—Vergers entre Locarno et Minusio, Tessin. *Herb. Kew.*

The creeping root, simple stem, and exserted corolla-scales clearly separate this species from all others except *S. Zeyheri*, and from this it is distinguished by the smaller basal leaves, which are less abruptly contracted into the petiole, and by the rather smaller corolla. The root is very slender and far creeping—in Bischoff's figure it is 4·5 dcm. long—unbranched, with a few rootlets at the base of the stem and on the tubercles. The leaves are more often rounded at the base than in *S. tuberosum*, but are sometimes gradually attenuated into the petiole.

De Candolle states that a Swiss specimen in his possession has small flowers with the corolla-scales and style scarcely exceeding the corolla, but that it must undoubtedly be referred to this species. The plant from Solduno, Locarno, has similar flowers. In the olive groves on the Italian Riviera *S. bulbosum* grows to a large size; in Mr. C. Bicknell's herbarium there are plants with leaves measuring 17 cm. long and 9 cm. broad.

Schimper's description is taken from plants growing in the vineyards at Heidelberg. If *S. bulbosum* is native here, this must be the most northerly extension of its area.

23. S. ZEYHERI, *Schimp. in Flora*, xii. (1829) p. 418.

Radix repens, gracilis, teres, tubera subrotunda invicem gerens. *Caulis* simplex vel apice bifidus, interdum a basi ramosus vel gemmas in axillis inferioribus gerens, pubescens et setis retrorsis quandoque tuberculatis vestitus. *Folia* ovata vel oblongo-ovata, parce setosa, inferiora mediis vix minora, basi subcordata vel rotundata cum mediis in petiolum alatum contracta vel attenuata, summa subdecurrentia. *Racemi* pauciflori. *Rachis* et pedicelli dense pubescentes et parce pilosi. *Calyx* pubescens, ad tertiam partem inferiorem in lacinias lineari-lanceolatas subacutas ciliatas fissus. *Corolla* ochroleuca, infundibuliformis, in dentes breves ovatos vel triangulares fissa, calycem duplo subtriplove excedens. *Fornices* lineari-lanceolati, obtusiusculi, exserti. *Antheræ* basi apiculatæ, filamenta triplo excedentes. *Nuculæ* rectiusculæ, supra basin constrictæ, reticulato-rugosæ, minute tuberculatæ.

Tubercula 1–3 cm. diam.; caulis 2–4 dcm. altus; folia inferiora 6–9 cm. longa, 4–5·5 cm. lata, media 9–12 cm. longa, 4–5 cm. lata; flores cum fornicibus 14-16 mm. longi; calyx 5–7 mm. longus; corolla 10–14 mm. longa; nuculæ 3·5–4 mm. longæ, 3 mm. latæ.

S. tuberosum, Ucria, Hort. Reg. Pan. p. 83 (1789), non Linn.

S. bulbosum, Guss. Fl. Sic. Prod. i. p. 219 (1827), non Schimp.

S. brochum, Bory & Chaub. Exp. Morée, p. 65, t. 7 (1832).

S. Zeyheri, Schimp.; Guss. Floræ siculæ, Syn. p. 226 (1842); Guss. Enum. Pl. Vasc. Inarime, p. 218 (1854).

S. tuberosum: *S. Zeyheri*, Schimp. forma *grandiflora*, Caruel in Parl. Fl. Ital. vi. p. 879 (1884); M. Lojacono Pojero, Fl. Sic. p. 66 (1902).

GEOGR. DISTR.—S. ITALY: Sicily, Sardinia, Corsica. GREECE.

SPECIMENS EXAMINED:—S. brochum, Bory & Chaub. Morée. Chaubard. *Herb. Cons. Bot. Genev.*—S. Zeyheri, Schimp. Sicily. M. Parlatore, 1841. *Herb. Cons. Bot. Genev.*—S. bulbosum, Schimp. Greece. Boissier, 1844. *Herb. DC.*—S. Zeyheri, Schimp. R. Oreto, Gratia, Sicily. E. & A. Huet de Pavillon, 1855. *Herb. Cons. Bot. Genev.*, *Kew.*, and *Univ. Cantab.*—S. brochum, Bory & Chaub. Khan Simeno, Rashova, Mons. Parnassus. Heldreich, Herb. Graec. Norm. 744, 1857. *Herb. Mus. Brit.* and *Cons. Bot. Genev.*—Taygetus, Greece, 1862. *Herb. Kew.*—S. Zeyheri, Schimp. Palermo. Todaro, Fl. Sic. exsic. No. 1394. *Herb. Univ. Cantab.* and *S. Lond. Bot. Inst.*—S. bulbosum. Schimp. In valle Dumbrek. P. Sintensis, Iter Trojanus, No. 42, 1883. *Herb. Kew.* and *Mus. Brit.*—S. Zeyheri, Schimp. R. Oreto, Palermo. Dr. Guzzino, 1889. *Herb. Bicknell.*—R. Oreto, Palermo. Dr. I. di Giovanni, Pl. Sic. exsic. cent. iv. 415, 1891. *Herb. Bicknell.*—S. bulbosum, Schimp. Macomer, Sardinia. Leg. C. Bicknell & L. Pollini, 1904. *Herb. Bicknell.*—S. Zeyheri, Schimp. R. Molinello, Augusta, Province of Catania, Sicily. Béguinot, Fl. Ital. exsic. 947, 1905. *Herb. Bailey.*—Corsica. G. C. Druce, 1905. *Herb. Fielding.*—Hirpinia, Avellino (S. Italy). A. Trotter, 1907. A. Béguinot, Fl. It. exsic. No. 947 bis. *Herb. Fielding* and *Bicknell.*

This differs from *S. bulbosum* much in the same way that *S. mediterraneum* differs from *S. tuberosum.* The plant is generally less tall and more compact, the lower leaves are more broadly ovate, rounded or subcordate at the base, and nearly as large as the succeeding ones, and the corolla is larger and infundibuliform. The stem often bears rudimentary branches in the lower axils and is occasionally branched at the base. Schimper states that it is easily distinguished at first sight and from afar, and that he had seen many complete flowering and fruiting specimens in *Herb. Zeyheriano.* He describes the teeth of the fruiting-calyx as narrower than those of *S. bulbosum*, but in Sicilian plants containing well developed fruit, I find that the teeth are at least as broad as in that species.

Béguinot, on the label of an excellent specimen from Augusta, Sicily, quotes Gussone (Fl. Sic. Syn. i. p. 226), who says that the characters of *S. Zeyheri* are constant, and (Enum. Pl. Vasc. Inar. p. 218) that "It is not a southern form of *S. bulbosum*, for that species also occurs with us, but in the mountain region, never in the lowlands, and careful comparison shows that they do not pass into each other." Béguinot continues that he can confirm this conclusion with regard to a plant from Ischia, erroneously recorded as

S. bulbosum, and that the same form is found in Capri and Nisida. However this may be, the plants named *S. Zeyheri* by Béguinot, from Avellino, S. Italy, are scarcely distinguishable, at least when dry, from *S. bulbosum*.

The plant gathered by Mr. Clarence Bicknell in Sardinia is similar to Sicilian specimens.

24. S. CORDATUM, *Waldst. & Kit. apud Willd. in Act. Soc. Berol.* ii. (1799) p. 121.

Radix horizontaliter repens, subcylindrica, subcarnosa, folia bina aut terna e quorum medio anno proximo caulis proditurus est, proferens. *Caulis* simplex, glabrescens vel setulis retrorsis parce obsitus. *Folia* pauca, ampla, repanda, suborbiculari-ovata, acuminata, sursum parce setulosa, subtus pubescentia, radicalia et caulina inferiora longe petiolata, summa ovato-lanceolata, sessilia. *Racemi* breves, pauciflori. *Rachis* pedicellique minute pubescentes et parcissime pilosi. *Calyx* pubescens, ad quartam partem inferiorem in lacinias lanceolatas ciliatas fissus. *Corolla* ochroleuca, calyce subduplo longior. *Fornices* subulati, subacuti, stamina superantes. *Antheræ* utrinque apiculatæ, filamentis duplo longiores. *Nuculæ* oblongæ, rectiusculæ, supra basin subconstrictæ, valde rugoso-reticulatæ, minute tuberculatæ.

Radix ad 1 cm. crassa ; caulis 2–4·5 dcm. altus ; folia majora 12–15 cm. longa, 12 cm. lata ; flores 15–18 mm. longi ; calyx 10–13 mm. longus ; corolla 13–16 mm. longa ; nuculæ 4 mm. longæ, 3 mm. latæ.

S. cordatum, Waldst. & Kit. Pl. rar. Hung. i. p. 6, t. 7 (1802).
S. pannonicum, Pers. Syn. i. p. 161 (1805).
S. cordifolium, Baumg. Enum. Stirp. Transs. i. p. 126 (1816).
S. cordatum, Waldst. & Kit., Reich. Pl. crit. iii. t. 240. fig. 395 (1825) ; Fl. exc. i. p. 347 (1832) ; Icon. Fl. Germ. t. 102. fig. 2 (1857) ; DC. Prod. x. p. 40 (1846) : Ledeb. Fl. Ross. iii. p. 116 (1846–51).

GEOGR. DISTR.—HUNGARY : Banat, Transylvania. GALICIA. MOLDAVIA. RUSSIA : Volhynia.

SPECIMENS EXAMINED :—S. cordatum ex Hungaria. M. Schrader, 1810. *Herb. Cons. Bot. Genev.*—Ex Alp. Carpath. Mr. Sieber, 1816. *Herb. Smith* in *Herb. Soc. Linn.*—Résbánya. Sadler. *Herb. J. Lindley* in *Herb. Univ. Cantab.*—Thal Borkutovski. L. Vágner, 1851. *Herb. Cons. Bot. Genev.*—Raho, im Thale Vilsinsky. L. Vágner, 1882. *Herb. J. W. White.*—Kalmk, Zips, 1886. *Ex herb. Ullepitsch. Herb. C. Bicknell.*—Siebenbürgen (Transylvania). *Herb. Bailey.*—Banat. v. Welden. *Herb. Fielding.*

The large, subglabrous, deeply cordate leaves distinguish this from all other species. The description of the root and manner of growth is taken from Waldstein & Kitaibel's 'Pl. rar. Hung.' The figure there given shows a root with two branches, one bearing a flowering stem and the other a tuft of radical leaves. *S. grandiflorum* differs in the decumbent caulescent barren shoots.

25. S. GRANDIFLORUM, *DC.*, *Prod.* x. p. 40 (1846).

Radix crassiuscula, intricato-ramosa, repens, ramos longos prope originem caulium incrassatos et squamosos edens. *Surculi* steriles decumbentes, anno proximo caules floriferos erectos simplices vel a basi parce dichotome ramosos setis longiusculis reflexis parce obsitos proferentes. *Folia* tenuiter puberula et setulis sparsis deciduis tuberculatis aspera, ea surculorum sterilium crassiusculorum ampla, ovata, acuminata, cordata, in petiolum longum anguste alatum contracta, ea caulium floriferorum gracilium ovata vel ovato-lanceolata, in petiolum alatum contracta vel attenuata, inferiora mediis minora, summa sessilia, breviter decurrentia. *Racemi* pauci- vel multi-flori, fructiferi elongati, erecti. *Rachis* et pedicelli pubescentiâ pilisque sursum curvatis vestiti. *Calyx* parce pilosus, infra tertiam partem inferiorem in lacinias lineares obtusas subglabras conspicue ciliatas fissus. *Corolla* ochroleuca, calyce triplo quintuplove longiore. *Fornices* lineares, obtusi, stamina vix superantes. *Antheræ* basi obtusæ, filamenta subæquantes. *Nuculæ* curvatæ, late ovatæ, supra basin constrictæ, obsolete rugosæ, tuberculatæ, fuscæ.

Caulis 2–3 raro 4 dcm. altus ; folia surculorum sterilium 6–10 cm. longa, 3–6 cm. lata ; caulium floriferorum 2–4 cm. longa, 1·5–2·5 cm. lata ; flores 12–22 mm. longi ; calyx 6–7 mm. longus ; corolla 12–20 mm. longa ; nuculæ 3 mm. longæ, 2·4 mm. latæ.

S. cordatum, Bieb. Fl. Taur.-Cauc. i. p. 130 (1808).
S. ibericum, Stev. in litt. ex Bieb. l. c. iii. p. 647 (1819).
S. grandiflorum, DC., Ledeb. Fl. Ross. iii. p. 116 (1846–51).
S. ibericum, Stev., Obs. Asperif. p. 579 (1851).
S. grandiflorum, DC., Boiss. Fl. Orient. iv. p. 172 (1879) ; Kusnez. Cauc. Sp. Gen. Symph. p. 45, t. i. fig. 12 (1910).

GEOGR. DISTR.—RUSSIA : W. Transcaucasia. TURKEY : Armenia.

SPECIMENS EXAMINED :—S. ibericum, Stev. Caucasus. *Herb. Boiss.*—S. cordatum, Willd. Georgia, Caucasus. Mr. Wilmsen par Mme. de Hahn, 1838. *Herb. DC.*—S. sp. Armenia. H. H. Calvert & J. Zohrab. No. 679. Recd. 1867. *Herb. Kew.* and *Fielding.*—Erzerum. J. Zohrab. *Herb. Kew.*—S. grandiflorum, DC. Inter Batum et Akhalzikh. S. Sommier & E. Levier, 1890. *Herb. Barbey-Boiss.*—Adjaria in Anticaucaso, 1890. *Herb. Barbey-Boiss.*—(Plantes d'Imérétie) A. Lomakin, 1893. *Herb. Barbey-Boiss.*—S. tauricum. Batum, 1893. *Herb. Barbey-Boiss.*—Mingrélie, Transcauc. N. Alboff, 1893–4. *Herb. Barbey-Boiss.*—Iter Persic. Szovits. ex herb. Hort. Petrop. Recd. 1899. *Herb. Kew.*

LIVING PLANTS :—S. sp. Cambridge Botanic Garden, Mr. R. I. Lynch, 1912.—Bristol Univ. Botanic Garden, Mr. Eves, 1912.—Botanic Garden, Geneva, 1912.

Var. ABCHASICUM, *Kusnez.*, *Cauc. Sp. Gen. Symph.* p. 46, t. 1. figs. 10, 13 & 14 (1910).—" Foliis radicalibus elliptico-ovatis, basi rotundatis, caulinis

ovatis ellipticisve, basi sensim angustatis vel rotundatis ; calycis fere ad basin 5-partiti *laciniis longissime acuminatis, corollæ tubum subæquantibus* ; nuculis minute granulatis, opacis."

S. abchasicum, Trautv. in Bull. Soc. Natur. Mosc. xliii. (1870) p. 72.

S. ibericum var., Stev. Observ. Asperif. p. 579 (1851).

GEOGR. DISTR.—RUSSIA : Kuban, Circassia, Abchasia.

S. grandiflorum is easily recognised by the decumbent barren shoots with broadly ovate, cordate leaves. In the second year the main axis of the shoot is prolonged into an erect flowering stem, while an axillary branch remaining decumbent, causes the main stem to appear lateral. The root is irregularly cylindrical and tortuous—not simple as stated by Kusnezow,—but copiously branched and far creeping. Its branches give rise to numerous stems which form large tufts. In the autumn the stems attain 3–5 dcm. in length, and the leaves increase greatly in size ; Stevens states that he had a specimen with a subrotund radical leaf half a foot long and broad which one would scarcely believe could belong to the same plant.

The corolla is very variable in size. De Candolle described it as 18–20 mm. long, but Steven states that the largest flower he had seen was only 12 mm. long. In the plant from Erzerum at Kew they are 20–22 mm., and in those from the Bristol and Cambridge Gardens they are about 18 mm. long.

The Bristol plant was already in fruit at the end of May 1912, and continued flowering throughout the year.

The var. *abchasicum* differs from the type in the cauline leaves being rounded or gradually attenuated at the base, and in the calyx-segments being nearly as long as the corolla-tube. I have seen no specimens.

HYBRIDS.

Hybrids between *S. officinale*, Linn. and *S. peregrinum*, Ledeb.

× S. DISCOLOR, Bucknall. (*S. officinale α. ochroleucum* × <*peregrinum*.)—*Planta* parce fertilis vel sterilis. *Caulis* 1·5–2 m. altus, ramosus, setis interdum in tuberculis insidentibus asper. *Folia* puberula setosaque, inferiora ovata, basi rotundata, in petiolum decurrentia, superiora lanceolata, acuminata, a basi dilatata decurrentia. *Racemi* breves, post anthesin paullo elongata. *Calyx* hispidus, ad tertiam partem inferiorem in lacinias lanceolatas acutas acuminatasve divisus ; fructifer subsetosus. *Corolla* tubuloso-infundibuliformis, ventricosa, albida vel colore dilute roseo cœruleove tincta, sicca cæsia, in lobos ovatos ad apicem interdum flavidos subreflexos fissa, calycem duplo-triplove excedens. *Fornices* subulati, obtusiusculi. *Antheræ* filamentis paullo longiores. *Stylus* vix exsertus, infra apicem inflexus. *Nuculæ* inter illas parentium intermediæ, ovatæ, curvatæ, oblique carinatæ, obsolete areolatæ, minutissime sparsimque granulatæ, supra basin latam leviter constrictæ, fusco-nigræ, nitidæ.

× *S. discolor*, Bucknall in Journ. Bot. l. (1912) p. 332.

HAB. With the parents on banks of streams and margins of woods in the counties of Gloucester and Somerset.

SPECIMENS EXAMINED: In *Herb. Kew.*, *Mus. Brit.*, *Univ. Cantab.*, and *Fielding.*

× S. CŒRULEUM, Petitmengin. (*S. officinale α. ochroleucum* × *peregrinum.*)—*Habitus S. peregrini.* Planta fere omnino sterilis. *Caulis* hispidus, asper, late sed incomplete alatus. *Folia* inferiora oblonga, in petiolum attenuata; superiora lanceolata, a basi latâ semidecurrentia. *Calyx* in lacinias acutas divisus. *Corollæ gemmæ* roseæ, apice virides, deinde corolla tota cœrulea vel roseo-cœrulea, apicibus loborum interdum flavidis. *Antheræ* filamenta æquantes. *Nuculæ* (sæpissime abortivæ) tuberculatæ.

S. cœruleum, Petitmengin in A. Thellung, Beiträge zur Kenntniss der Schweizerflora, viii. Separat, Dec. 14th, 1907, pp. 459–462.

× *S. cœruleum*, Petitmengin, Bucknall, *l. c.* p. 335. Conf. *S. peregrinum*, Ledeb.; Bot. Mag. t. 6466 (1879).

HAB. Britain. Botanic Gardens of Zurich and Bristol University; Sion, Switzerland, *cult.*; Doumartemont, France.

SPECIMENS EXAMINED:—*S. acutum.* In hort. Genev. cult. Juin, 1850. Huet de Pavillon. *Herb. Cons. Bot. Genev.*—*S. officinale* var. *patens*, Telford, Surrey. E. S. Marshall. *Herb. Mus. Brit.*—*S. peregrinum*, Selkirk, 1910. *Herb. G. C. Druce.*

× S. LILACINUM, Bucknall. (*S. officinale α. ochroleucum* × *β. purpureum* × < *S. peregrinum.*)—A *S. discolore* differt: foliis inferioribus elliptico-lanceolatis, in petiolum attenuatis, superioribus a basi latiori decurrentibus; corollæ gemmis purpureis, apice viridibus dein corollâ tota dilute purpureâ vel apice loborum flavidâ, siccâ purpureo-cæsiâ.

× *S. lilacinum*, Bucknall, *l. c.* pp. 334 & 337.

HAB. With the parents, on the banks of the Land Yeo, near Bristol, Somerset.

SPECIMENS EXAMINED: In *Herb. Kew.*, *Mus. Brit.*, *Univ. Cantab.*, and *Fielding.*

S. DENSIFLORUM, Bucknall. (*S. officinale β. purpureum* × > *peregrinum.*)—A × *S. discolori* differt: habitus *S. officinalis* sed caule sæpe elatiore; foliis inferioribus anguste oblongo-lanceolatis, basi breviter in petiolum attenuatis; floribus majoribus, confertioribus; corollæ rufo-violaceæ limbo latiore, corollâ siccâ purpurascente, nuculis sæpe olivaceo-nigris.

× *S. densiflorum*, Bucknall, *l. c.* pp. 334 & 337.

HAB. With the parents on the banks of the Land Yeo, near Bristol, Somerset.

SPECIMENS EXAMINED: In *Herb. Kew.*, *Mus. Brit.*, *Univ. Cantab.*, and *Fielding.*

× S. FERRARIENSE, Massalongo. *See addendum*, p. 556.

Hybrids between *S. officinale*, Linn. and *S. tuberosum*, Linn.

S. ZAHLBRUCKNERI, Sennholz.—"All leaves, especially the upper ones, elongate lanceolate, broadest at the middle, acuminate. Racemes mostly terminal. Calyx green. Corolla-scales exceeding stamens. Stem 2·6–3·4 dcm. high.

HAB. Lower Austria: Piesting between Waldegg and Öd."

Sennholz in Verh. zool.-bot. Ges. Wien, xxxviii. (1888) p. 69.

S. Zahlbruckneri ×, G. Beck, Fl. Nied. Oestr. ii. II. p. 964 (1893).

The above short description does not convey much information as to the exact position of this hybrid, but, the calyx being described as green, while in ×*S. Wettsteinii* it is described as purplish, it may be inferred that ×*S. Zahlbruckneri* = *S. officinale* α. *ochroleucum* × *S. tuberosum*. If this inference is correct, a plant gathered by the writer near St. Jean de Luz, France, in 1898, may be placed here. This has the habit of *S. tuberosum*, but the partially decurrent leaves, the hispidity of the inflorescence and the more numerous flowers, suggest the influence of *S. officinale*. The following is a description of the French plant:—

Caulis apice bifidus, anguste alatus, hispidus. *Folia* hispida, inferiora oblongo-elliptica, acuta, in petiolum brevem attenuata, superiora ovato-lanceolata, acuminata, sessilia, decurrentia. *Rachis* pedicelli calyxque dense hispidi, pilis eis *S. officinalis* similibus. *Racemi* satis multiflori. *Calyx* fere ad basin in lacinias subulato-lanceolatas acutas puberulas ciliatas fissus. *Corolla* ochroleuca, calyce duplo longior. *Fornices* stamina paullo excedentes. *Antheræ* filamenta triplo longiores.

Folia majora 11 cm. longa, 3–5 cm. lata; flores 15 mm. longi; calyx 7 mm. longus.

HAB. Ascain, S. Jean de Luz, France.

S. multicaule, Teyber (*S. officinale* × *tuberosum*). "Entirely fertile, seeds intermediate."

Teyber in Verh. zool.-bot. Ges. Wien. lviii. (1908) p. 13. "Im Steinbachthale bei Göstling."

×S. WETTSTEINII, Sennholz. (*S. officinale* β. *purpureum* × *tuberosum*.)—"Rhizomate breviter incrassato, obliquo, carnoso, nodoso, nigro, postice præmorso, antice radicibus secundariis decurrentibus affixo. Caule simplici vel superiore subramoso. Foliis breviter decurrentibus, inferioribus radicalibusque ovato-lanceolatis in petiolum sensim contractis, superioribus elliptico-lanceolatis. Calycibus subpurpurascentibus. Corollis ochroleucis in lineis ex apicibus laciniarum decurrentibus violascentibus."

S. Wettsteinii, G. Sennholz in Verh. zool.-bot. Ges. Wien, xxxviii. (1888) p. 69.

HAB. Lower Austria: Kalksburg, with the parents.

S. dichroanthum, Teyber, *l. c.* p. 13. "Im Pulkauthale bei Pulkau."

Hybrid between *S. officinale*, Linn. and *S. cordatum*, Waldst. & Kit.

× S. POLONICUM, Blocki. (*S. cordatum* × *officinale*.)—*Radix* . . . . . . *Caulis* subramosus, anguste alatus, puberulus et tuberculato-setosus. *Folia* radicalia ampla, late ovata vel oblongo-ovata, cordata, breviter acuminata, in petiolum longum decurrentia ; caulina ovata, basi rotundata vel subcordata, longe acuminata, petiolata, superiora sessilia, decurrentia, omnia puberula et magis minusve hispida vel tuberculato-setosa. *Racemi* multiflori, floribus amplis confertis. *Rachis*, pedicelli calyxque pubescentes. *Calyx* ultra tertiam partem inferiorem in lacinias ovato-lanceolatas acuminatas minute ciliatas fissus. *Corolla* campanulata, violaceo vel colore ochroleuco violaceoque variata, lobis latissimis brevibus. *Fornices* staminibus longiores. *Antheræ* filamentis duplo longiores.

Caulis 3–4 dcm. altus ; folia radicalia 22 cm. longa, 16 cm. lata, vel 14 cm. longa, 15 cm. lata ; caulina ad 16 cm. longa, 8–5 cm. lata ; flores 20 mm. longi ; calyx 6–10 mm. longus.

HAB. Galicia orientalis.

SPECIMEN EXAMINED :—*S. polonicum*, Blocki. Winniki pr. Leopolim, Galicia Orient. Leg. Br. Blocki, 1901–4. *Herb. Bailey.*

Hybrid between *S. tuberosum*, Linn. and *S. bulbosum*, Schimp.

× S. BICKNELLI, hybr. nov. (*S. bulbosum* × *tuberosum*.)—*Radix* repens, tubercula subrotunda, elongata vel multiformia gerens. *Folia* inferiora basi rotundata, in petiolum subito contracta, superiora in petiolum alatum attenuata, summa sessilia decurrentia. *Corolla* subcampanulata, calycem duplo excedens. *Fornices* breviter exserti.

Flores cum fornicibus 14–16 mm. longi, corolla 11–13 mm. longa.

HAB. ITALY : Liguria.

SPECIMENS EXAMINED :—*S. bulbosum* × *tuberosum*, Bicknell. Val Borghetto, Bordighera, 1889 ; Vallecrosia, Bordighera, 1895. *Herb. Bicknell.*

Hybrid between *S. tuberosum*, Linn. and *S. cordatum*, Waldst. & Kit.

× S. ULLEPITSCHII, Wetts.—*Rhizoma* obliquum, carnosum non vel modice nodosum. *Caulis* simplex vel apice inflorescentiâ bifidâ, breviter et remotiuscule hispidus. *Folia* ovata, acuminata, basi subito contracta et paullulum decurrentia, vel sensim angustata et decurrentia, mollia, breviter setulosa. *Corolla* pallide ochroleuca, tubo lacinias calycis longitudine superante, in faucem valde dilatata.

Caulis 2·5–4 dcm. altus ; folia media in speciminibus majoribus 8–12 cm. longa, 5–7 cm. lata ; flores 17–11 mm. longi, calyx 5–9 mm. longus.

Wettstein in Kerner, Schedæ ad Fl. exsic. Aust.-Hung. vi. p. 37, No. 2130 (1893).

S. cordatum × *tuberosum*, Ullepitsch in Oestr. bot. Zeitschr. p. 209 (1886).

Hab. Hungary.

Specimens examined :—*S. Ullepitschii*, Wetts. Ad ripas fluvii Dunajec prope Roth-Kloster, Hungaria, Jos. Ullepitsch. *Herb. Fielding* and *Bailey*. Pienen, Zips, Hungaria, Jos. Ullepitsch, 1892. *Herb. Bailey*, *Bicknell*, and *J. W. White*.

According to Wettstein, this hybrid does not develop fruit. The specimens which I have seen are mostly nearer to *S. tuberosum* than to *S. cordatum*.

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ADDENDUM.

Hybrid between *S. officinale*, Linn., and *S. orientale*, Linn.

× S. FERRARIENSE, C. Massalongo. (*S. officinale* × *orientale*.)—*Folia* caulina et floralia in petiolum caulemque anguste decurrentia. *Calyx* fere ad medium in dentes subovatos divisus.

S. ferrariense, C. Massalongo in Bull. Soc. Bot. Ital. No. 6 (1913), p. 78.

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